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August 10, 2021
Revised August 19, 2021

Mr. Tom Fantoni
MAS Building & Bridge, Inc.
18 Sharon Avenue
Norfolk, MA, 02056

Subject: **Locks Pond Road Bridge Replacement**
Control of Water Plan
Shutesbury, Massachusetts
Pare Project No.: 21139.00

Dear Mr. Fantoni:

Please find the attached design information for the Control of Water submittal to support the proposed repairs to the bridge over the Sawmill River along Locks Pond Road in Shutesbury, Massachusetts. Included with the letter are:

1. Plans
2. Bulk Bag Cofferdam Design Calculations
3. Pipe Flow Capacity Calculations
4. Scour Calculations

REVISION NOTES

As part of this revision Pare offers the following notes:

1. Several notes on Sheet 1.0 were added.
2. The pipe alignment and downstream cofferdam location on Sheet 2.0 were changed based on reviewer comments and MAS proposed alignments.
    a. Note that alignments as shown on the plan are to be interpreted as general in nature, and the MAS may make changes in the field as needed due to field conditions.
    b. As a result of the realignment of the piping, the overall pipe length has been changed to approximately 160 feet (from 179 feet) and one additional 22.5 degree bend has been added. Based on the equivalent pipe length chart submitted within this document a 45 degree bend is approximately equal to 21.5 feet. As the reduction in overall pipe length is less than that of the equivalent length added due to the additional 22.5 degree bend, no changes were made to the supporting calculations.
3. Minor grammatical edits were made to this document.

GENERAL METHODOLOGY

The following section describes the general methodology used to determine the parameters required to develop this control of water plan.

Survey

Elevation information was obtained from the project drawings and documentation.

In general, the channel elevation at the upstream limits of the work area varied between 822.0 and 822.5. The channel elevation at the downstream limits of the work area was near elevation 821.2.

The Lake Wyola Dam (MA00510) is located approximately 130-feet upstream of the project site. The dam has a toe elevation of approximately 826.0 feet, a spillway elevation of 830.8 feet, a top of dam elevation of 834.0 feet , and a low level outlet invert elevation of 822.87 feet. The low-level outlet is an approximately 35-inch diameter PVC conduit.

Flow Requirements

Based on Section/Item 991.1 of the specifications and the Order of Conditions (DEP File #286-0270) from the Shutesbury Conservation Commission the dewatering system shall be "capable of re-routing the typical base flow through the adjacent dam of 8 cubic feet per second, with a contingency plan to increase the capacity of the dewatering system in the event of higher than expected seasonal flow or a large storm event".

According to the Streamstats regression equations for the site the average expected 50% duration flows are 6.8 cfs year-round and 2.5 cfs for the month of August.

MAS intends to cofferdam the river to elevation 825.0 feet and install a 2x pipe by-pass system to accommodate the required flows. The required base flows of 8 cfs can be passed with a single pipe, with a second pipe being included for contingent capacity. The system as designed, with 18-inch ID double wall corrugated HDPE pipes (22-inch OD, ADS pipe) is expected to be able to handle 9.5 cfs per pipe. This will allow for approximately 1.5 feet of freeboard for at the design flow of 8 cfs and capacity for up to 19 cfs with no freeboard. MAS also intends to have on-call a 12-inch diameter pump which can handle an additional 4600 gpm (10.25 cfs). Beyond those flow rates the cofferdam can be expected to overtop and flood the work area.

Cofferdam elevations were set to limit upstream water surface elevations to 826.5 during the 2-year storm event to limit the development of a tailwater along the Lake Wyola Dam. Additional details on elevation determination are stated in the "Upstream Cofferdam Elevation" section of this letter.

Upstream Cofferdam Elevation

Channel surface elevations in the proposed location of the upstream cofferdam vary between 822.0 and 822.5 feet. It was assumed that bulkbags used to create the cofferdam could be filled such that they would measure 2'-8" tall, by 3'-0" wide, by 3'-0" deep. Only filling to 2'-8" tall fills the bag with less material than it can hold will allow the bag to conform to the channel and the bags surrounding.

Pare modeled the capacity of the pipes in HydroCAD (Version 10.10-5a). Based on the alignment of the by-pass system, as shown on Sheet 2, the overall length of the pipes was assumed to be approximately 179 feet. Within the alignment of the pipe there are three proposed 22.5-degree bends and one 11.25-degree bend. Based on the attached reference for equivalent lengths for pipe fittings, an equivalent length of 21.5 feet per bend has been assumed[1], resulting in an overall pipe length of 263 feet and an assumed slope of 0.0038 ft/ft. The

[1] Note that the provided reference is for copper piping which has a Manning's coefficient of 0.011, similar to that of HDPE pipe which ranges from 0.009 to 0.011. Additionally the assumed equivalent length of 21.5 feet is for a single mitered 45 degree bend, which has been assumed for a single 22.5 degree and single 11.25 degree bends.

resulting upstream water elevations were compared to proposed cofferdam elevations. Under normal flow conditions (i.e. less than 8 cfs) Pare assumed a downstream tailwater elevation of 821.5 feet. Under the 2-year year storm event conditions a downstream tailwater of 825 feet was assumed.

An upstream cofferdam elevation of 825 feet has been established. Note that when flows exceed 20 cfs it is likely that there is limited time (less than 1 hours) before the cofferdam would be subject to overtopping. In the event of a significant storm event overtopping of the cofferdam will occur. The upstream cofferdam elevation has been set in part to allow for overtopping of the cofferdam for events up to the 2-year storm event without creating an upstream impoundment that would form a significant tailwater on the upstream dam. As such the elevation of the Sawmill River during a 2-year event is estimated to be 826.4 feet. In reviewing available survey of the upstream areas, it appears that the toe of the downstream slope for the Lake Wyola dam is near 826.5 feet. Further impacts to the discharge capacity of the dam were not evaluated.

2-year storm flow events were taken as defined in the StreamStats regression equations for the site.

At this elevation, all cofferdam configurations have a factor of safety against sliding of 2.5 or greater and the resultant force is within the middle-third indicating that all configurations are stable against overturning. If bottom of cofferdam elevations are below that stated within these procedures Pare must be contacted to re-evaluate the cofferdam configuration in those areas.

Pipe Alignment

Based on an 18-inch diameter ADS pipe the overall pipe length will be approximately179 feet. With an invert elevation of no higher than 822.5 and in outlet elevation of no higher than 821.5 the pipe will have an average slope of approximately 0.0055 ft/ft. It is estimated that three 22.5-degree bends and one 11.25-degree bend will be required at each pipe. If available bends up to 45-degrees may be used. Pipes must maintain a constant downward slope from upstream to downstream; however steeper/shallower than the average 0.005 ft/ft are permissible.

Note that pipe lengths are approximate based on the proposed alignment shown on the attached drawings. Changes in slope and/or pipe location will affect the overall length of the pipe. Pipe lengths as presented herein shall only be used for estimating overall quantities required.

Pipe Spacing

When passing through the upstream/downstream cofferdams and along their alignment, pipes shall maintain a minimum spacing such that compaction equipment can adequately compact granular fill materials between the pipes and beneath the spring lines. This will allow for the packing of additional material between the pipes including soils, grout, or flowable fill cement in the event soils are washed out from beneath the pipe. Pipes shall not be touching at any point in their alignment. When placing pipe, backfill material must be compacted beneath the spring line between and outside of the pipes, this may require wider spacing between the pipes. Alternatively, narrower spacing may be feasible if the space beneath the springline between the pipes is filled with a flowable fill concrete material. Note that when placing flowable fill material around the pipe spring lines the pipes will require anchoring or floating may occur.

Pipe Burial and Thrust Resistance

After passing through the upstream cofferdam the by-pass pipes are proposed to be buried along the alignment. Several sections of pipe may be exposed depending on natural grades through the in-field pipe alignment.

Exposed section of pipe shall be anchored as detailed at pipe joints. Pipe anchoring may consist of three bulk bags along the same alignment with two bags on the outside of the pipes and a single bag set atop the pipes. If pipes exhibit deflection from the bag set atop the pipes, a plate may be laid across the top of the pipe or material removed from the bag until deflection is negligible.

At buried bends along the pipe alignment a single 2'x2'x3' concrete block or sand filled bulk bag can be placed for thrust resistance.

Pipes must be buried with a minimum of 12-inches of material to support up to H-25 loading. Backfill must be either Class I material or Class II material compacted to no less than 90% of the modified proctor value. For descriptions on fill classes see the table on the following page.[2]

AVERAGE VALUES OF MODULUS OF SOIL REACTION, E' (FOR INITIAL FLEXIBLE PIPE DEFLECTION)					
	PIPE BEDDING MATERIALS	E' FOR DEGREE OF COMPACTION OF PIPE ZONE BACKFILL (PSI)			
SOIL CLASS	SOIL TYPE (Unified Classification System[a])	Loose	Slight < 85% Proctor, < 40% relative density	Moderate 85% - 95% Proctor, 40% - 70% relative density	High > 95% Proctor, > 70% relative density
Class V	Fine-grained Soils (LL>50)[b] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use E' = 0			
Class IV	Fine-grained Soils (LL < 50)Soils with medium to no plasticity CL, ML,ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Class III	Fine-grained Soils (LL < 50)Soils with medium to no plasticity CL, ML,ML-CL, with more than 25% coarse-grained particles 1004001,0002,000 Coarse-grained Soils with Fines GM, GC, SM, SCC contains more than 12% fines	100	400	1,000	2,000
Class II	Coarse-grained Soils with Little or No Fines GW, GP, SW, SPC contains less than 12% fines	200	1,000	2,000	3,000
Class I	Crushed Rock	1,000	3,000	3,000	3,000
	Accuracy in Terms of Percentage Deflection	±2	±2	±1	±0.5

Flow into Work Area

During preparation of this Control of Water Plan, three potential sources of water infiltration to the work area were identified: seepage under the upstream/downstream cofferdams, seepage into the excavation, and overland flow from precipitation events. To address seepage under the cofferdams, Pare completed a seepage model in the Seep/w module of GeoStudio (version 11.1.0.22070). Using available subsurface information provided in the drawing set, Pare modeled the seepage expected to flow under the cofferdam. Pare modelled the effects that extending an impermeable membrane (i.e. polyethylene sheet) 20-feet upstream of the cofferdam to provide cutoff capacity. In general, at the base of the cofferdam a seepage rate of 0.00015 cfs/ft of cofferdam was calculated assuming a maximum water surface elevation of 825 feet. With a cofferdam length of approximately 50 feet exposed to excavation the estimated inflow from seepage under the cofferdam is 2.5 gpm (this value is acceptable for use on the downstream cofferdam as well

It is assumed that runoff water from the site will be limited due to the small footprint of the site. If drains from exiting roadway drainage structure remain active during construction, pipes with couplings should be attached and run to the upstream or downstream cofferdams and discharge flows directly into the Sawmill River to be handled by the by-pass system.

Pare recommends that MAS have a variety of 2- and 3-inch diameter sumps onsite capable of pumping and discharging the stated flows. At a minimum, sumps shall be placed at 20-foot intervals within the drainage trenches as shown on the plans.

[2] "Depth of Burial for PVC Pipe", Technical Bulletin, JM Eagle, January 2009.

Pare recommends that MAS have on-site 3 additional 2-inch diameter pumps to handle flows more than those calculated or to supplement pumps in areas of concentrated flow. The excavation of small diversion trenches or sandbag barriers (see Cofferdam Detail C-1) to collect surface waters and divert flow towards unwatering trenches and pumps may be required and should be completed by MAS at their discretion based on channel surface elevations and the exact location of outfalls.

Groundwater during Excavations

See "Flow into Work Areas" for expected groundwater flows.

Seepage & Slope Stability

Utilizing data from the existing boring logs provided in the Contract Drawings, soil properties were developed for the in-situ soils using references which correlate blow count data from SPT sampling with geotechnical properties of soil. These properties were used to develop a seepage and slope stability model of the proposed cofferdam geometry. Seepage rates were calculated assuming a drainage trench along the base of the cofferdam and base of the excavation and results are presented in the "Flow into Work Areas" section of this letter. Drainage trenches were installed at these locations to reduce the water pressure on the excavation slope and lower the groundwater table below the bottom of excavations. Slope stabilities were calculated utilizing the pore water pressures developed in the seepage models. Factors of safety for slope stability above 1.2 were considered acceptable for temporary construction conditions. Critical to maintaining the presented slope stabilities are the following conditions:

- The excavated slope can be no steeper than 2H:1V.
- Drainage trenches must be installed as shown on the dewatering plans.

Scour Considerations

During an overtopping event it can be expected that flow will slowly rise above the cofferdam and spill onto the downstream toe of the cofferdam. This process will be a slow progression and it is expected that the work area will flood to the tailwater elevation prior to the development of significant flows. Based on an estimated flood elevation of 2-inches above the cofferdam it will take less than 30 minutes to flood the work area The presence of a tailwater will limit the development of scour forces. However, to deal with initial overtopping the reinforced polyethylene sheets extending 4 feet beyond the toe of the cofferdam will be sufficient to prevent scour at the toe of the cofferdam. MAS will also implement actions within the Construction Flood Contingency Plans (under a separate cover). Once the work area has been flooded risk of scour is reduced.

Scour Force Calculations were based upon two methodologies: Veronese (1973) and Schoklitsch (1932). The Veronese method is based solely upon the differential height between the upstream and downstream water elevations and flow, while the Schoklitsch method considers the size of the subgrade within the scour area. During the start of a flood event the downstream side of a cofferdam is "in the dry" and as such would be the point at which the scour energy is at its greatest. However, overtopping flows will increase slowly allowing for the work area to flood and a tailwater to develop. As the tailwater develops the differential height between the overtopping flow and the tailwater will reduce and in turn reduce the potential scour depth. As noted in the preceding paragraph the time in which the excavation is anticipated to be filled with water is assumed to occur prior to extensive scour forces being able to develop. Based on this methodology, should overtopping occur or be about to occur, it is recommended that MAS use available riprap on-site to line the downstream side of both cofferdams.

The calculations performed are for overtopping flows at the cofferdam, soils to the left and right of the cofferdam will still be subject to scour from flows due to overland flows. To avoid scour related to overland flow MAS shall follow the notes set forth in the Construction Flood Contingency section of the Contract Drawings and General Notes sheet.

At the discharge pipes 4-to-8-inch riprap will need to be placed within 5 feet of the pipe discharges to address initial discharge from the pipes. Following that distance, the natural river channel bedding will be sufficient to resist discharge velocities given expected elevated tailwater conditions at the point of discharge. If existing channel bedding meets these requirements additional riprap is not needed. If riprap is not available, MAS can used rubber tire blast mats at the pipe outfalls.

CONTROL OF WATER PROCEDURES

The descriptions and sequences for the construction of the anticipated control of water elements can be found on Sheet 1.0 General Notes of the attached drawings. Sequences include installation of the bulk bag temporary cofferdams, installation of sumps for water control within the cofferdams, and the removal of the installed control of water systems at the completion and acceptance of the work.

Material Notes

The attached calculations were completed using the following materials. If MAS plans to use other materials to complete the work the materials shall at a minimum meet the product specifications for these materials. If it cannot be confirmed or it is known that the proposed product does not meet the minimum specifications of the stated items, then Pare shall be contacted to review the calculations with the material properties of the proposed products.

1. By-Pass Pipe:
    a. All by-pass pipe to be push fitting ADS N-12 ST IB pipe
    b. Have a inside diameter of 18-inches (22-inch outside Diameter).
    c. HDPE to be PE2XXX, PE3XXX or PE4XXX pipe
2. Bulk Bags
    a. As Manufactured by Mutual Industries, Inc. or equal.
    b. To have a 5:1 Safety Factor

MONITORING PROCEDURES

During the progression of the project the site will be exposed to a variety of environmental, meteorological, and man-made conditions. The site foreman or superintendent should inspect the cofferdam at the beginning of each shift. Prior to using the cofferdam any damaged portions or potentially hazardous conditions within the cofferdam should be remedied. Potential hazards to look for include, but are not limited to:

- Piping or boiling water rising from the ground surface within the cofferdam area;
- Displaced/gaps between super sack sandbag sections of the cofferdam;
- Sliding or leaning sections of the cofferdam;
- Rips in sandbags that is allowing or has the potential to allow the contents to spill out (on lower sections this could result in destabilization of stacked bags);
- Rips in polyethylene sheeting (reducing the cutoff ability of the cofferdam system);
- Increased river flow and/or forecasted flows;
- Increased amounts of water within the cofferdam area;

- Increased discharge rates of dewatering pumps without a change in river flow conditions;
- Debris within the cofferdam area;
- Change in any of the above conditions due to construction induced vibrations; and
- Contractor equipment striking the cofferdam.

Conditions that may lead to heightened levels of monitoring include, but are not limited to:

- Weather forecasts indicating precipitation events.
- Upstream dam owners discharging elevated amounts of water (MA00510 Lake Wyola Dam, Owned by the Town of Shutesbury) in response to or anticipation of a significant rainfall event or to implement a winter drawdown.

The Contractor should be aware of these events and how they relate to rising water levels. Throughout the duration of the project, water levels and the effects of varying water levels on the cofferdam should be monitored. Modifications made to the cofferdam should be logged and reported to the Engineer.

The Owner of the Lake Wyola dam is the Town of Shutesbury. In the event of an emergency that may impact the dam, the primary contact is the Fire Chief, Mr. Walter Tibbetts, who can be reached at 413-259-1211.

The Operator of the Lake Wyola dam is the Lake Wyola Advisory Committee. The primary contact is Mr. Mark Rivers and can be reached at 413-367-9945. The dam keeper is Mr. Howard Kinder and can be reached at 413-367-9515.

Please call us at 508-543-1755 if you have questions or need additional information.

Sincerely,

PARE CORPORATION

COMMONWEALTH OF MASSACHUSETTS
DAVID R. CAOUETTE
CIVIL
No. 54023
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PLANS AND NOTES

SHEET 1: General Notes
SHEET 2.0: Site Plan
SHEET 3.0: Cofferdam Details

UP/DOWNSTREAM BULKBAG COFFERDAM INSTALLATION:

A BULKBAG COFFERDAM WILL BE USED UPSTREAM AND DOWNSTREAM OF THE BRIDGE TO ALLOW FOR DRY WORKING CONDITIONS. BULKBAG COFFERDAM INSTALLATION SHALL BE AS FOLLOWS:

1. THE BULKBAG SACKS WILL CONSIST OF 3-FOOT WIDE BY 3-FOOT LONG BY 2-FOOT 8-INCH (MAX.) TALL, WOVEN POLYPROPYLENE, BAGS FILLED WITH A UNIFORM SAND OR SAND GRAVEL FILL THAT HAS A MINIMUM UNIT WEIGHT OF 115 POUNDS PER CUBIC FOOT.
   a. BAGS SHOULD NOT BE FILLED SUCH THAT THEIR HEIGHT EXCEEDS 2-FEET 8-INCHES, AS THIS WILL FILL THE BAG TO CAPACITY AND WILL LIMIT THE ABILITY OF THE BAG TO CONFORM TO THE CHANNEL SURFACE AND/OR THE SURROUNDING BAGS.
   b. IF NECESSARY, TO ACHIEVE SHAPE TO FIT, BAGS MAY BE FILLED LESS THAN THE STATED DIMENSIONS; HOWEVER, EXCESS BAG MATERIAL MUST BE CAREFULLY PULLED TAUNT AND FOLDED OVER TO CREATE A UNIFORM SURFACE FOR ADJACENT BAGS TO CONTACT.
   c. IF BAGS ARE FILLED TO LESS THAN THE STATED DIMENSIONS UP TO ONE ADDITIONAL VERTICAL BAG MAY BE PLACED TO ACHIEVE THE STATED ELEVATIONS FOR ANY GIVEN COFFERDAM CONFIGURATION.
2. PRIOR TO PLACING BULKBAGS THE CONTRACTOR SHALL REMOVE DEBRIS, IN SO MUCH AS POSSIBLE, TO PROVIDE A UNIFORM CHANNEL BOTTOM ALONG THE COFFERDAM ALIGNMENT.
3. IF REQUIRED, DUE TO UNEVEN CHANNEL SURFACE, THE BULKBAG CAN BE PLACED ON A CUSHION OF STANDARD 14 INCH BY 26-INCH WOVEN POLYETHYLENE SANDBAGS. SANDBAGS SHALL BE PLACED SUCH THAT A CONTINUOUS SURFACE IS CREATED. THE SANDBAG CUSHION SHOULD NOT EXCEED 6 INCHES IN HEIGHT.
5. THE UPSTREAM COFFERDAM SHALL HAVE A TOP ELEVATION OF 825.0 FEET. TO ALLOW FOR AT LEAST 0.5-INCHES OF FREEBOARD TO BE MAINTAINED, BASED ON A 3,600 GPM (8 CFS) REQUIRED BASE FLOW RATE. THE COFFERDAM BAG CONFIGURATION FOLLOW THE TABLE ON SHEET 3.0.
6. THE BULKBAGS MUST BE STACKED IN CONFIGURATIONS AS SHOWN ON THE CONTROL OF WATER PLANS UNLESS OTHERWISE SUBMITTED AND APPROVED BY THE PARE.
7. BULKBAGS SHALL BE PLACED ABUTTING ONE ANOTHER SUCH THAT THERE ARE NO GAPS BETWEEN THE BAGS.
8. UPPER BULKBAG ROWS SHALL BE OFFSET HALF A BAG FROM SUPPORTING ROW, SUCH THAT VERTICAL SEEMS DO NOT ALIGN.
9. REINFORCED POLYETHYLENE SHEETS SHALL BE PLACED FROM 4 FEET BEYOND THE DOWNSTREAM TOE OF THE BULK BAGS, UP AND OVER THE COFFERDAM, AND DOWN ALONG THE CHANNEL BOTTOM AND SHALL EXTEND AT LEAST 20 FEET INTO THE CHANNEL. THE PERIMETER OF THE POLYETHYLENE SHEETS SHALL BE WEIGHED DOWN WITH SANDBAGS PLACED SIDE BY SIDE.
   a. ALTERNATIVELY, THE UPSTREAM END OF THE POLYETHYLENE SHEET MAY BE TOED INTO THE CHANNEL VIA EXCAVATION AND BACKFILL.
   b. SEAMS IN REINFORCED POLYETHYLENE SHEETS SHOULD BE ORIENTED IN THE LEFT/RIGHT DIRECTION NOT UPSTREAM/DOWNSTREAM.
   c. SEAMS SHOULD OVERLAP A MINIMUM OF 5 FEET WITH THE UPSTREAM SHEET ON TOP OF THE DOWNSTREAM SHEET.
   d. A CONTINUOUS LINE OF SANDBAGS SHALL BE PLACED ON THE UPSTREAM AND DOWNSTREAM ENDS OF THE OVERLAPPED SECTIONS.
11. WHEN SETTING THE BULK BAG COFFERDAM AGAINST A SLOPE, THE CONTRACTOR SHALL SET THE BULK BAGS TO AT LEAST ELEVATION 825.0. POLYETHYLENE SHEETING SHALL EXTEND TO AT LEAST ELEVATION 827.0 ALONG THE CHANNEL SLOPES. IF TREES ARE PRESENT THE POLYETHYLENE SHEET SHOULD BE CUT AND SANDBAGS INSTALLED AROUND THE TREE AND ATOP THE CUT SEAM. THE POLYETHYLENE SHEETS SHALL CONTINUE ALONG THE SLOPE FOR AT LEAST 20 FEET UPSTREAM OF THE END OF BULK BAGS.
12. THE POLYETHYLENE SHEETS SHALL BE INSTALLED WITH ENOUGH SLACK AT CORNERS AND POTENTIAL HARD POINTS SO THAT WHEN WATER PRESSURE IS APPLIED THE SLACK IS SUFFICIENT TO MOLD TO THE BACKSTOP SURFACE. IF ENOUGH SLACK IS NOT GIVEN THE SHEET MAY TEAR AND ALLOW WATER THROUGH THE SHEET, COMPROMISING THE COFFERDAM.
13. MAS MUST MONITOR ACTUAL FLOW DEPTHS WITHIN THE CHANNEL, WIND AND WAVE ACTION CONDITIONS, COFFERDAM SETTLEMENT, STORM CONDITIONS, AND OTHER MONITORING REQUIREMENTS IDENTIFIED WITHIN THE FLOOD CONTINGENCY PLAN. IF A STORM THAT WOULD RESULT IN A HIGHER WATER LEVEL WITHIN THE CHANNEL IS FORECASTED, IT IS RECOMMENDED THAT THE AREA BEHIND THE COFFERDAM BE EVACUATED OF ALL PERSONNEL, EQUIPMENT, AND MATERIALS.
14. MAS WILL MONITOR THE PERFORMANCE OF THE COFFERDAM FOR THE DURATION OF ITS USE, SPECIFICALLY FOR INDICATIONS OF MOVEMENT OR INCREASED LEAKAGE.
   a. IF MOVEMENT, INCREASED LEAKAGE, OR ANY OTHER CONDITION INDICATING POTENTIAL FAILURE OF THE COFFERDAM SYSTEM IS OBSERVED, MAS WILL ADDRESS THE ISSUE BEFORE RETURNING TO WORK.
   b. A SITE SUPERINTENDENT FROM MAS WILL INSPECT THE COFFERDAM AT THE START OF EACH WORKING DAY TO DETERMINE IF THERE IS DAMAGE TO THE COFFERDAM OR IF ANY MODIFICATIONS ARE REQUIRED.
   c. PERSONNEL WORKING WITHIN THE COFFERDAM WILL BE INSTRUCTED TO REPORT ANY DAMAGE OR CHANGE IN CONDITIONS OF THE COFFERDAM PERFORMANCE.
   d. IF THE BULKBAG COFFERDAM IS STRUCK BY EQUIPMENT OR IS DAMAGED DURING CONSTRUCTION ACTIVITIES, THE COFFERDAM ELEMENT SHALL BE INSPECTED, REPAIRED OR REPLACED PRIOR TO CONTINUING WORK.

COFFERDAM INSTALLATION

THE FOLLOWING SEQUENCE DESCRIBES THE PROPOSED METHOD OF INSTALLING THE COFFERDAM:

1. EXCAVATE THE ROADWAY TO THE REQUIRED ELEVATIONS AND SET THE BURIED SECTIONS OF BY-PASS PIPES AND TRUST BLOCKS.
2. BACKFILL THE PIPES WITH CLASS II FILL TO 92% OF THE MODIFIED PROCTOR VALUE OF THE FILL MATERIAL.
3. PLACE SANDBAGS IN THE DOWNSTREAM CHANNEL TO REDIRECT STREAM FLOWS AND ALLOW THE PARTIAL INSTALLATION OF THE DOWNSTREAM RIPRAP APRON.
4. INSTALL THE DISCHARGE SECTIONS OF BY-PASS PIPE IN THE DOWNSTREAM CHANNEL. ALIGN THE DISCHARGE PIPES TO DIRECT FLOWS ALONG THE PARTIALLY CONSTRUCTED RIPRAP APRON.
5. ON THE UPSTREAM SIDE SET THE SANDBAG CUSHION BEGINNING FROM NORTH TO SOUTH ACROSS THE CHANNEL. AS SANDBAG CUSHION PROGRESSES SET THE FIRST ROW OF BULK BAG SACKS ATOP THE CUSHION UNTIL THE BYPASS PIPE LOCATION HAS BEEN REACHED.
6. SET A BED OF SMALL SANDBAGS TO A MAXIMUM ELEVATION OF 822.5 BENEATH THE PROPOSED PIPE ALIGNMENT. THE INVERT OF THE BY-PASS PIPES SHALL BE NO HIGHER THAN ELEVATION 822.5.
7. CONSTRUCT/INSTALL THE INLETS FOR THE ADS PIPES AND SET IN PLACE WITHIN THE RIVER CHANNEL AND WITHIN THE UPSTREAM COFFERDAM. FLOOD THE PIPES AND ANCHOR INTO PLACE WITH BULK BAGS PLACED AS NEEDED ALONG THE DOWNSTREAM SECTIONS TO PREVENT MOVEMENT.
8. ONCE PIPES ARE SET IN PLACE HAND PACK SANDBAGS AROUND THE PIPES WITHIN THE FOOTPRINT OF THE COFFERDAM. DUE TO THE CORRUGATED EXTERIOR OF THE ADS PIPES, FILLING OF THE CORRUGATIONS WITH OAKUM OR OTHER WATERTIGHT SEALANT MATERIAL WILL BE REQUIRED TO ADEQUATELY SEAL THE PIPE AGAINST THE SANDBAGS.
9. ONCE PIPES ARE ANCHORED CONTINUE CONSTRUCTING THE FIRST LINE OF BULK BAGS ACROSS THE CHANNEL, THEN SET THE SECOND ROW OF BULK BAGS ATOP THE INTAKE PIPE TO ANCHOR THE PIPES. MAS MAY ELECT TO CONSTRUCT THE COFFERDAM OF SIMILIAR GEOMETRY TO THE A OR B BAG CONFIGURATIONS FROM SMALL SAND BAGS ALONG THE SLOPE AS THE TOP OF COFFERDAM ELEVATION IS BEING APPROACHED.
10. IF THE UPSTREAM DAM OWNER ALLOWS A HIGHER COFFERDAM ELEVATION. CONTINUE EXTENDING THE SECOND ROW OF BULK BAGS BEYOND THOSE USED TO ANCHOR THE PIPE INTAKES.
11. INSTALL POLYETHYLENE SHEETING UPSTREAM OF THE COFFERDAM. WHEN INSTALLING THE PIPES THE POLYETHYLENE SHEETING SHALL BE CUT TO ALLOW THE PIPE PENETRATION. SUFFICIENT SLACK SHOULD BE PRESENT AROUND THE SHEETING TO ALLOW FOR SOME OVERLAP ON THE PIPE IN THE UPSTREAM DIRECTION. SANDBAGS SHALL THEN BE PLACED AROUND THE UPSTREAM SIDE OF THE OF SHEETING TO FORM A SEAL AGAINST THE PIPES. IF EXCESS LEAKAGE CONTINUES, MAS MAY CUT AND FIT A NEOPRENE GASKET (OR OTHER CLOSED CELL/SOLID MATERIAL) AROUND THE PIPE TO BE PLACED BETWEEN THE UPSTREAM SIDE OF THE POLYETHYLENE SHEETS AND THE HAND PACKED SAND BAGS.
12. ONCE THE COFFERDAM HAS BEEN INSTALLED AND FLOWS ARE CONTROLLED INSTALL SUMP PITS/PUMPS AT 20-FOOT SPACING ALONG THE DOWNSTREAM SIDE OF THE COFFERDAM WITHIN THE NORMAL RIVER CHANNEL. CONNECTING THE SUMP PITS WITH A SHALLOW CRUSHED STONE TRENCH MAY BE BENEFICIAL IF WATER CONTINUES TO SEEP THROUGH THE SANDBAGS BETWEEN SUMP PITS.

COFFERDAM INSTALLATION <CONT.>

13. SPACING BETWEEN PIPES SHALL BE SUFFICIENT TO ALLOW COMPACTION EQUIPMENT TO ADEQUATELY COMPACT SOILS BENEATH THE PIPES, OR TO ALLOW THE PLACEMENT OF FLOWABLE FILL.
14. INSTALL THE DOWNSTREAM COFFERDAM BY PLACING A SINGLE ROW OF BULK BAGS ACROSS THE CHANNEL. AT THE BY-PASS PIPE LOCATION INSTALL A BED OF SMALL SANDBAGS AND SET THE BY-PASS PIPES.
15. ONCE INSTALLED HAND PACK SAND BAGS AROUND THE BY-PASS PIPES.
16. INSTALL POLYETHYLENE SHEETING AND INSTALL RIPRAP SCOUR PROTECTION AT THE PIPE OUTFALLS AS SHOWN ON THE DRAWINGS.
17. IT IS RECOMMENDED THAT PRIOR TO STARTING/COMPLETING THE COFFERDAM INSTALLATION. MAS INSTALL THE POLYETHYLENE SHEETING UNDER LOW FLOW CONDITIONS WHERE PRACTICAL. PRIOR TO COFFERDAM INSTALLATION FLOW WILL BE AT A SHALLOWER MORE MANAGEABLE LEVEL OF ±3 FEET. IN AREAS WHERE PE SHEETING CANNOT BE INSTALLED PRIOR TO COFFERDAM INSTALLATION, A DIVER MAY BE REQUIRED TO INSTALL THE SHEETING AFTER WATER LEVELS RAISE. IF NECESSARY THE PIPE INTAKES CAN BE TEMPORARILY BLOCKED TO ACCOMMODATE A DIVER. IF PIPES ARE BLOCKED THE MAS WILL NEED TO ~~MONITOR THE RIVER ELEVATIONS TO PREVENT COFFERDAM OVERTOPPING.~~
18. PIPES SHALL REMAIN UNOBSTRUCTED AT BOTH THE INTAKE AND DISCHARGE AREAS ACROSS THE FULL DIAMETER. NO DEBRIS GUARDS, FILTERS, OR SCREENS SHALL BE INSTALLED.
19. COFFERDAM LOCATIONS AS SHOWN ON SHEET 2.0 ARE INTENDED TO BE GENERAL IN NATURE. THE CONTRACTOR SHALL RESERVE THE RIGHT TO CHANGE THE ALIGNMENT OF THE PIPE(S) AS NEEDED TO MEET FIELD CONDITIONS. CHANGES IN ALIGNMENT SHALL BE REPORTED TO PARE TO ASSESS FOR CHANGES IN FLOW CAPACITY.

REMOVAL OF WATER CONTROLS

REMOVAL OF COFFERDAMS WILL BE AS FOLLOWS:

1. REMOVE ALL EQUIPMENT, MATERIALS, AND CONSTRUCTION DEBRIS WITHIN COFFERDAM AFTER WORK HAS BEEN COMPLETED AND ACCEPTED.
2. REMOVE THE DEWATERING BASINS.
2. REMOVE AND FILL SUMPS AND FLOOD THE COFFERDAM AREA.
3. REMOVE THE DOWNSTREAM COFFERDAM PROGRESSING FROM THE SOUTH SIDE OF THE CHANNEL TO THE NORTH.
4. REMOVE THE TOP LAYER OF SANDBAGS FROM THE UPSTREAM COFFERDAM PROGRESSING FROM THE SOUTH SIDE OF THE CHANNEL TO THE NORTH.
5. REMOVE THE DISCHARGE PIPES TO THE STREAM SLOPE. RESET SANDBAGS AS NEEDED TO ISOLATE PIPE SECTION IN THE CHANNEL SLOPES FOR EXCAVATION AND REMOVAL.
6. REMOVE THE INTAKE PIPES TO THE STREAM SLOPE AND ALLOW FLOW THE RETURN TO THE CHANNEL. RESET SANDBAGS AS NEEDED TO ISOLATE PIPE SECTION IN THE CHANNEL SLOPES FOR EXCAVATION AND REMOVAL.
7. EXCAVATE AND REMOVE THE BURIED SECTIONS OF BY-PASS PIPING. BACKFILL THE ROADWAY EMBANKMENT IN ACCORDANCE WITH PROJECT SPECIFICATIONS.
8. REMOVE THE TEMPORARY SANDBAGS USED TO REDIRECT RIVER FLOWS DURING PIPE REMOVAL.
9. REMOVE THE REMAINING COFFERDAM COMPONENTS PROGRESSING FROM THE EAST SIDE OF THE CHANNEL TO THE WEST.

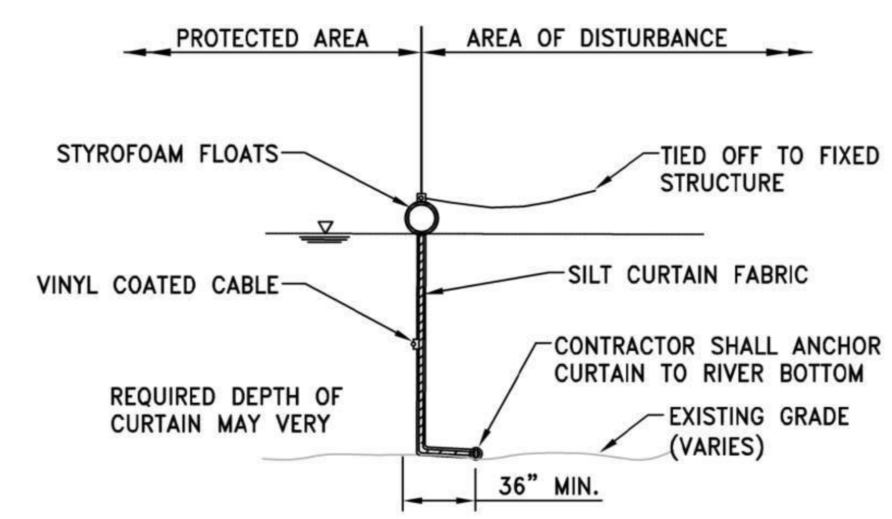
UNWATERING WITHIN INSTALLED COFFERDAMS

UNWATERING SUMP PITS AND SANDBAG/POLYETHYLENE DIVERSION SWALES WILL BE CONSTRUCTED TO COLLECT AND REMOVE WATER THAT ENTERS THE WORK AREA BY MEANS OF SEEPAGE AROUND THE COFFERDAM, RAINFALL, AND STORMWATER DISCHARGE FROM THE SURROUNDING AREA. THE PURPOSE OF THE SUMP PIT IS TO REMOVE WATER FROM THE WORK AREA. IT IS ANTICIPATED THAT WATER ENTERING THE WORK AREA VIA THE PREVIOUSLY MENTIONED MEANS WILL BE PUMPED BACK INTO THE CANAL DIRECTLY FROM THE SUMP LOCATIONS TO ENTER THE BY-PASS SYSTEM, OR BE PASSED INTO THE DOWNSTREAM AREA.

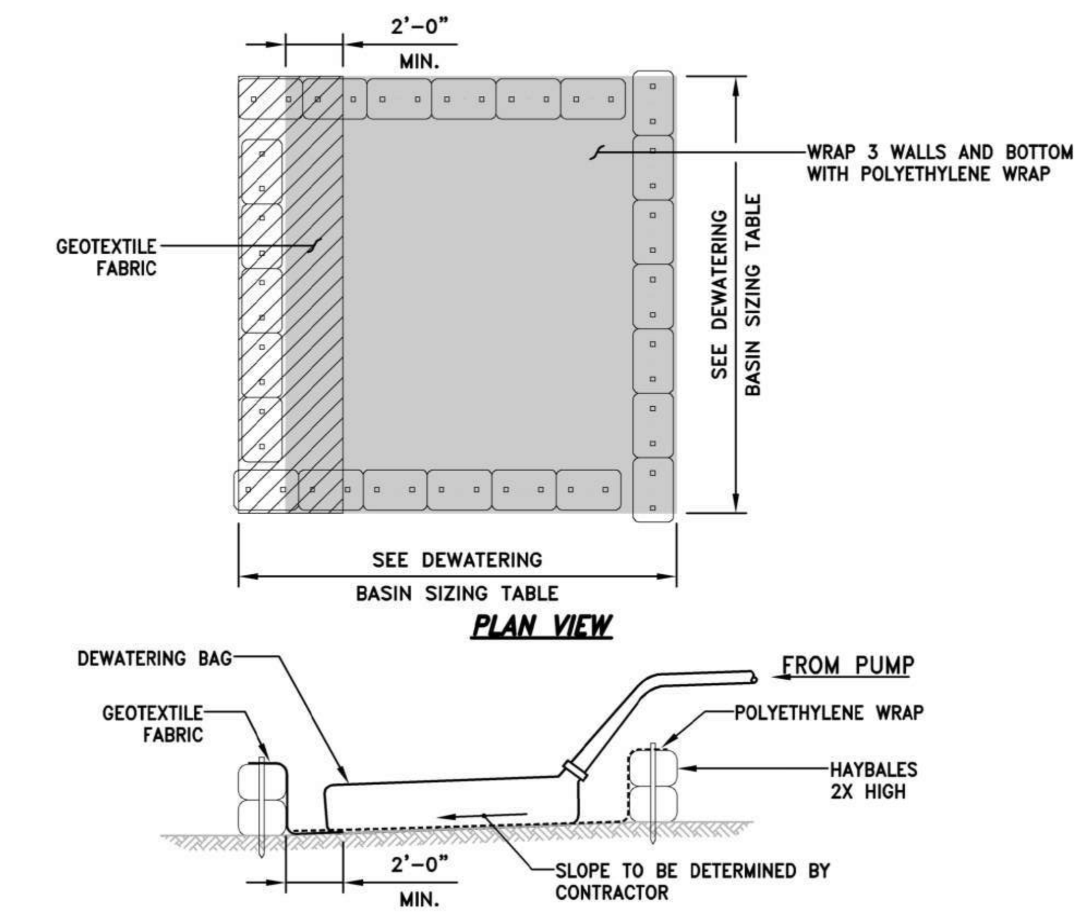
1. SUMP PUMPS SHALL BE INSTALLED WITHIN DRAINAGE TRENCHES LOCATED AT THE BASE OF THE COFFERDAM AND THE TOE OF THE EXCAVATION TO ALLOW BOTH INITIAL REMOVAL OF WATER WITHIN THE COFFERDAM AND CONTINUED REMOVAL OF WATER ENTERING THE COFFERDAM THROUGH LEAKS, SEEPS, STORM RELATED RAINFALL, AND GROUNDWATER.
   a. IT IS ESTIMATED THAT 0.00132 CFS PER FOOT OF DRAINAGE TRENCH ALONG THE BASE OF THE COFFERDAM (APPROXIMATELY 75 GPM) WILL SEEP THROUGH THE SOILS BENEATH THE UPSTREAM COFFERDAM IF THE WATER REACHES THE TOP OF COFFERDAM ELEVATION.
   b. IT IS ESTIMATED THAT 0.00358 CFS PER FOOT OF DRAINAGE TRENCH ALONG THE BASE OF THE EXCAVATION (APPROXIMATELY 230 GPM) WILL SEEP THROUGH THE SOILS AT THE TOE OF THE EXCAVATION IF THE WATER REACHES THE TOP OF COFFERDAM ELEVATION.
2. SUMP PUMPS WILL CONSIST OF 2-INCH AND 3-INCH SUBMERSIBLE PUMPS PLACED IN A 1-FOOT WIDE BY 24-INCH TO 36-INCH DEEP TRENCHES FILLED WITH CRUSHED STONE.
   a. IF REQUIRED (DUE TO EXCESSIVE FINE SEDIMENT OR DEBRIS INTAKE), THE CONTRACTOR SHALL ENCLOSE THE PUMP IN A PERFORATED PIPE SURROUNDED BY CRUSHED STONE.
   b. SUMPS SHALL BE PLACED AS SHOWN ON THE PLANS.
   c. THE PLAN CALLS FOR 6, 2 OR 3-INCH DIAMETER SUMPS (CAPABLE OF 370 GPM) AT THE UPSTREAM COFFERDAM AND EXCAVATION, AND 2, 2- OR 3-INCH DIAMETER PUMPS CAPABLE OF 120 GPM AT THE DOWNSTREAM COFFERDAM. MAS SHALL BE PREPARED TO MOBILIZE ADDITIONAL 2-INCH PUMPS AS NEEDED TO MEET POTENTIAL INFLOWS.
3. ONCE GROUNDWATER FLOWS HAVE STABILIZED THE SUMPS WILL BE COLLECTING FILTERED GROUNDWATER THAT HAS ENTERED THE WORK AND WAS COLLECTED IN DRAINAGE TRENCHES, IT IS ASSUMED THAT THE WATER WILL BE FLOWING CLEAN AND CAN BE PUMPED DIRECTLY BACK TO THE CHANNEL. DEWATERING BASINS ARE NOT ANTICIPATED FOR PUMPING OF GROUNDWATER.
4. DURING INITIAL EXCAVATION AND AFTER PRECIPITATION EVENTS THAT CAUSE EROSION OF EXPOSED SOILS PRETREATMENT WILL LIKELY BE REQUIRED. DISCHARGES FROM PUMPS SHALL BE PUMPED THROUGH DEWATERING BAG(S) OR A HAY/STRAW BALE LINED DEWATERING BASIN PRIOR TO DISCHARGING TO THE UPSTREAM OR DOWNSTREAM CHANNELS.
5. SANDBAG/POLYETHYLENE DIVERSION SWALES SHALL FOLLOW THE C-1 BAG CONFIGURATION AND SHALL BE ERECTED AS NEEDED TO DIVERT SURFACE FLOWS AROUND CRITICAL WORK AREAS OR DIRECT DRAINAGE SYSTEMS THAT ENTER THE WORK AREA TO DRAINAGE TRENCHES.

ADDITIONAL COFFERDAM HEIGHT

THE PROPOSED HEIGHT OF ELEVATION 825.0 WILL ALLOW FOR THE TAILWATER POOL TO DEVELOP AT THE DOWNSTREAM TOE OF THE DAM. DUE TO THE LIMITING EFFECTS ADDITIONAL TAILWATER MAY HAVE ON THE DISCHARGE OF THE DAM AND POTENTIAL FLOODING OF ADJACENT RESIDENTIAL PROPERTIES DURING EVENTS LARGER THAN A 2-YEAR STORM, A COFFERDAM HEIGHT ABOVE 825.0 IS NOT RECOMMENDED.



TYPICAL TURBIDITY BARRIER
NOT TO SCALE



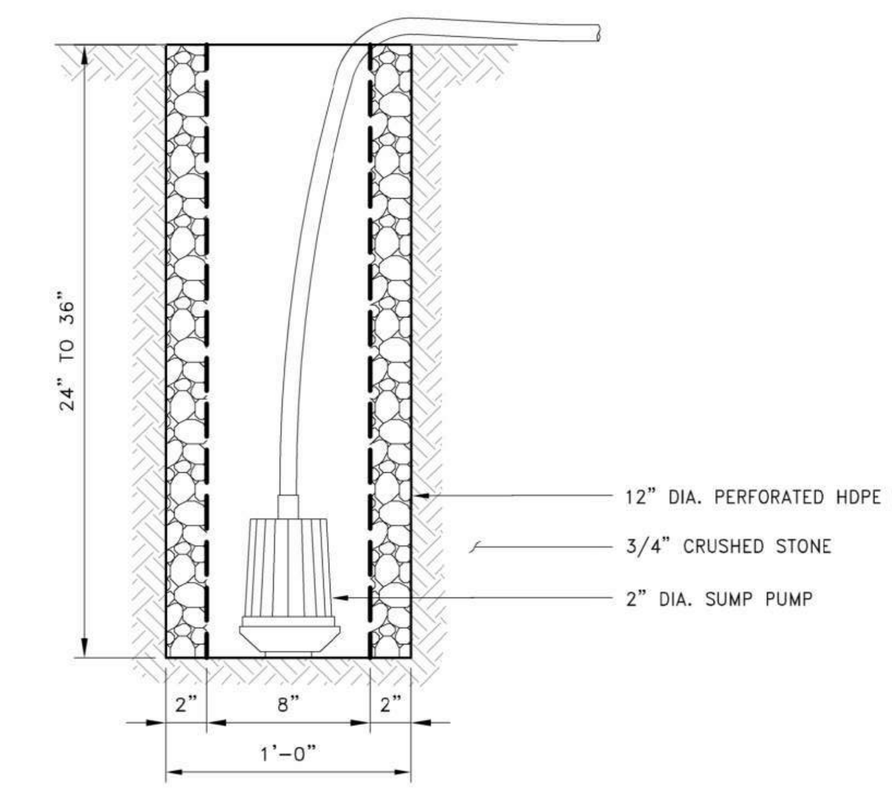
NOTES

1. IF A DEWATERING BAG IS USED, CONTRACTOR TO PERIODICALLY REPLACE DEWATERING BAG AS NEEDED PER MANUFACTURE RECOMMENDATIONS AND AS FLOW CONDITIONS WARRANT. DEWATERING BAGS SHOULD BE PLACED ON EXPOSED SOIL AND NEED NOT BE PLACED IN HAY/STRAWBALE LINED BASINS.
2. ALTERNATE TO USING A DEWATERING BAG A HAY/STRAW BALE LINED DEWATERING BASIN MAY BE CONSTRUCTED IN ACCORDANCE WITH THE DEWATERING BASIN SIZING TABLE BELOW.
3. IF A HAY BALE LINED DEWATERIN BASING IS USED, CONTRACTOR TO PERIODICALLY REMOVE SILT IN BASIN TO PROMOTE FLOW OF WATER FROM BASIN.

DEWATERING BASIN
NOT TO SCALE

AVG. PUMP RATE	BASIN SIZE
10 GPM	8FT X 9FT
50 GPM	18FT X 18FT
100 GPM	25FT X 26FT
150 GPM	31FT X 32FT
200 GPM	36FT X 36FT

DEWATERING BASIN SIZING TABLE



SUMP DETAIL
SCALE: 1-1/2"=1'-0"

FOR CONSTRUCTION

PARE
PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
508-543-1755

SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

LOCKS POND ROAD BRIDGE REPLACEMENT
CONTROL OF WATER AT LOCKS POND ROAD
SHUTESBURY, MASSACHUSETTS

PREPARED FOR: MAS BUILDING & BRIDGE
OWNERS:TOWN OF SHUTESBURY - DEPARTMENT OF PUBLIC WORKS

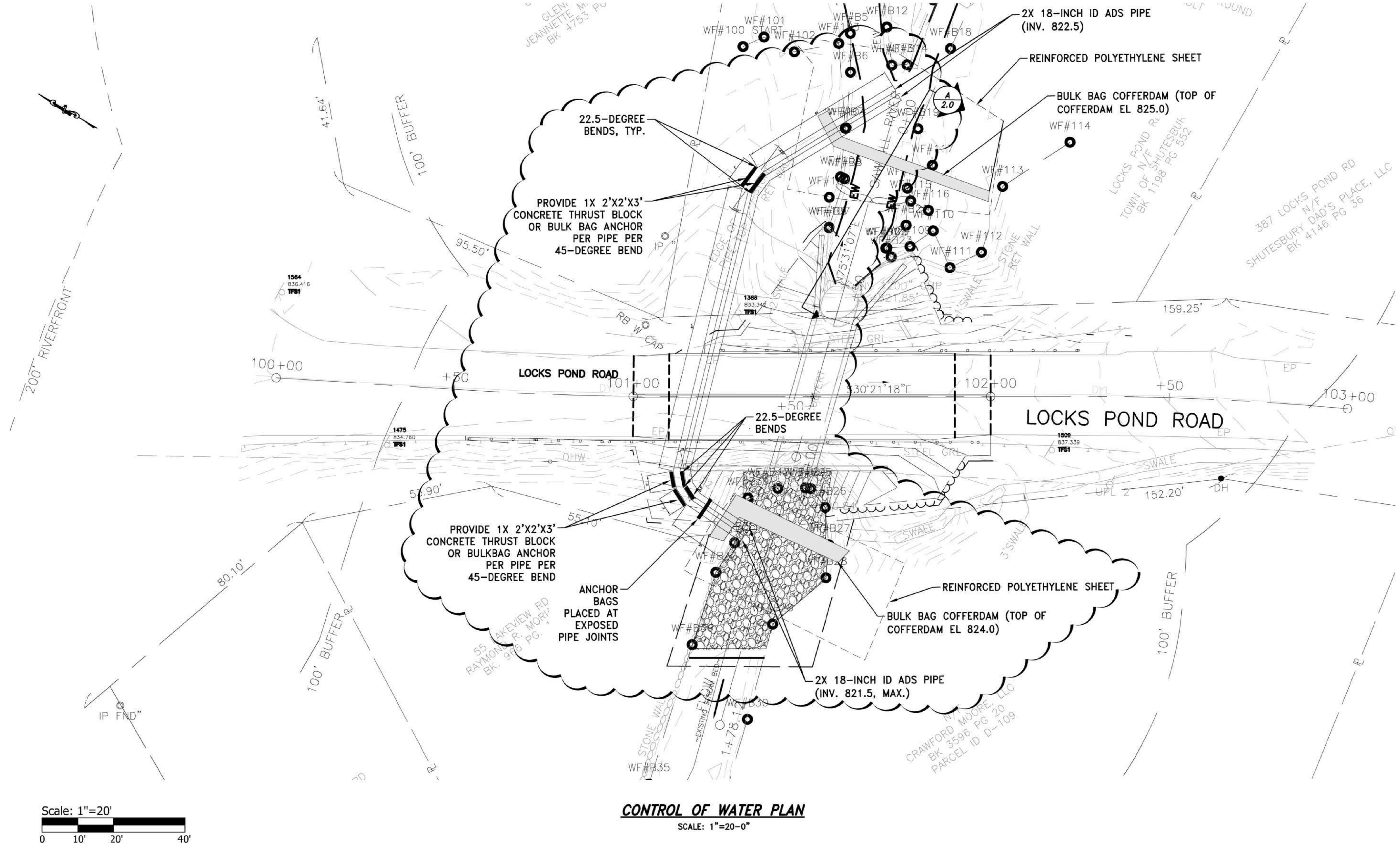
REVISIONS:

1	8-19-21	NOTE UPDATES

PROJECT NO.:	21139.00
DATE:	AUGUST 2021
SCALE:	AS NOTED
DESIGNED BY:	DRC
CHECKED BY:	JMB
DRAWN BY:	LMC
APPROVED BY:	DRC

GENERAL NOTES

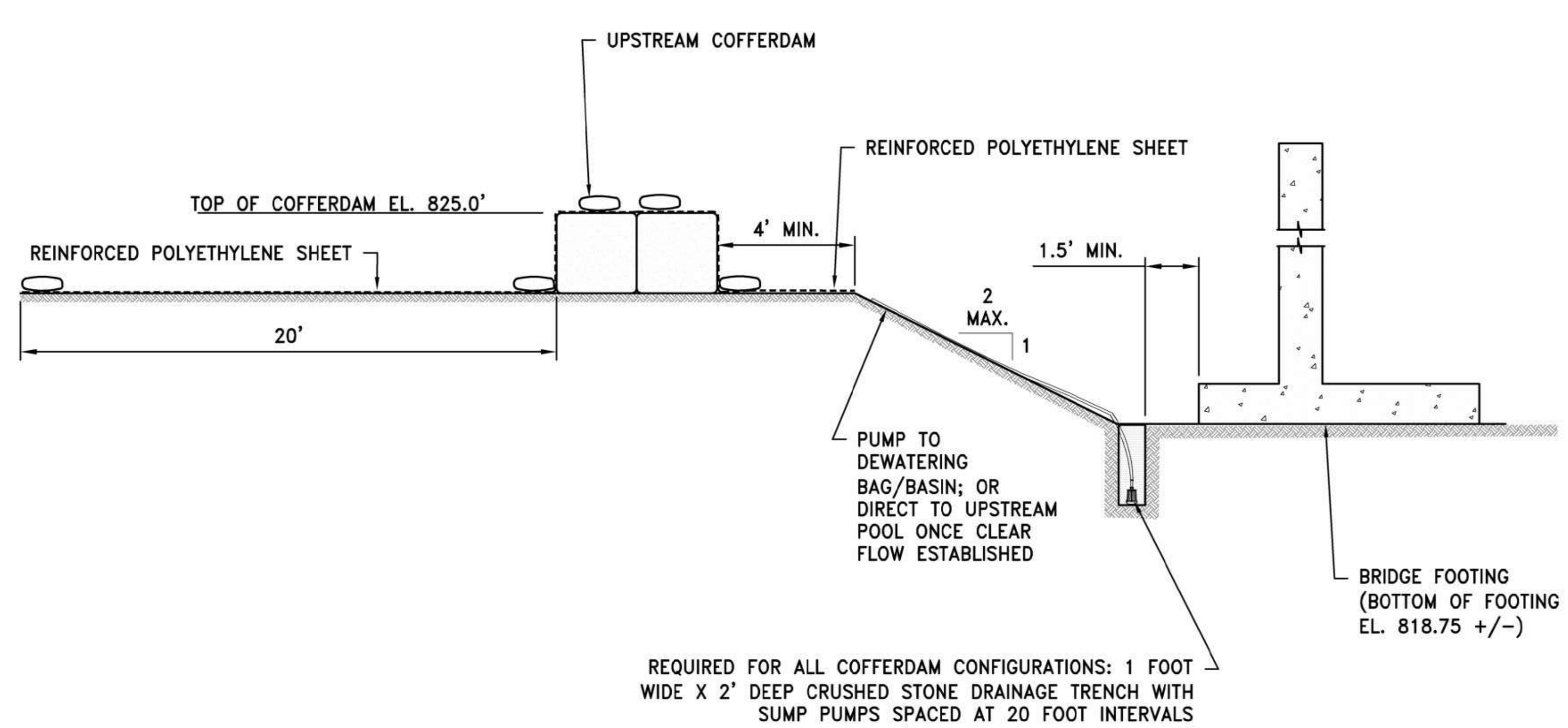
SHEET NO.:
1.0



CONTROL OF WATER PLAN
SCALE: 1"=20'-0"

NOTES:

1. PIPE TO MAINTAIN A 0.0055 FT/FT DOWNWARD SLOPE FROM THE UPSTREAM TO DOWNSTREAM DIRECTION
2. HDPE PIPE CONNECTIONS TO PUSH ON FITTINGS. ALL JOINTS SHALL BE BURRIED OR ANCHORED WITH BALLAST BAGS.
3. PIPES TO BE BURIED WITH A MINIMUM OF 1 FOOT OF CLASS I MATERIAL OR CLASS II MATERIAL COMPACTED TO 90% OF THE MODIFIED PROCTOR VALUE TO SUPPORT H-25 LOADING. PIPE SECTIONS NOT MEETING MINIMUM BURIAL CRITERIA SHALL NOT BE TRAVERSED WITH EQUIPMENT.
4. THE SURFACE OF THE CHANNEL SHALL BE EXCAVATED AS NECESSARY TO PROVIDE A SMOOTH SURFACE TO SEAT THE SANDBAGS.
5. THE ALIGNMENT OF THE BYPASS PIPES AND COFFERDAM AS SHOWN ON THIS DRAWING IS INTENDED TO BE GENERAL IN NATURE. PIPE LOCATIONS MAY BE ADJUSTED IN THE FIELD AS SURFACE CONDITIONS PERMIT.
6. BENDS ARE NOT TO EXCEED 22.5-DEGREES AND THRUST BLOCKS SHALL BE INSTALLED AT EACH BEND LOCATION. A SINGLE 2'X2'X3' CONCRETE BLOCK WILL PROVIDE SUFFICIENT THRUST RESTRAINT PER A 45-DEGREE BEND.



A/2.0 **SECTION A**
SCALE: 1"=5'

FOR CONSTRUCTION

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508-543-1755

SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

LOCKS POND ROAD BRIDGE REPLACEMENT
CONTROL OF WATER AT LOCKS POND ROAD
SHUTESBURY, MASSACHUSETTS

PREPARED FOR: MAS BUILDING & BRIDGE
OWNERS:TOWN OF SHUTESBURY - DEPARTMENT OF PUBLIC WORKS

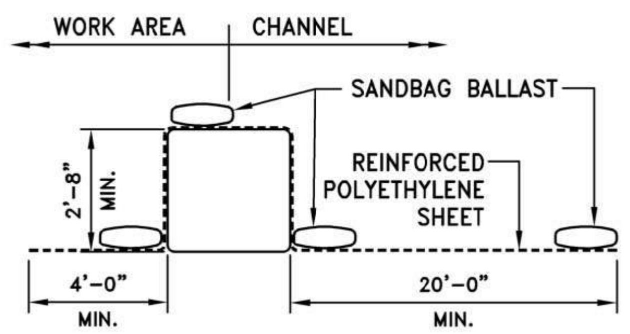
REVISIONS:

1	8-19-21	REVISED BYPASS PIPE ALIGNMENT & D/S DAM

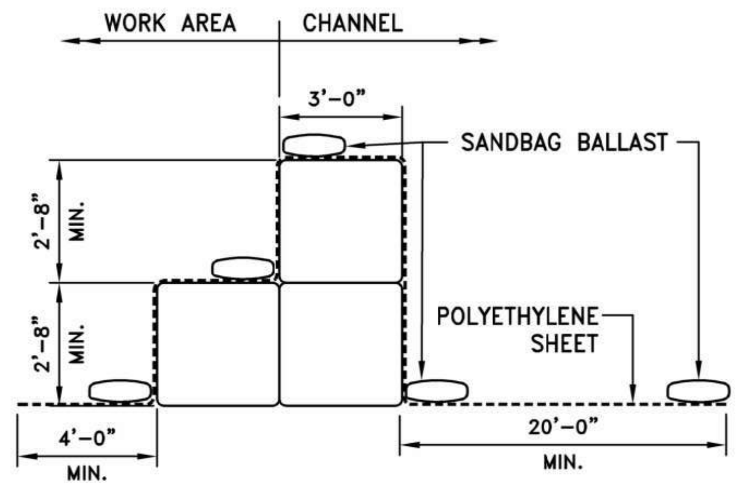
PROJECT NO.:	21139.00
DATE:	AUGUST 2021
SCALE:	AS NOTED
DESIGNED BY:	DRC
CHECKED BY:	JMB
DRAWN BY:	LMC
APPROVED BY:	DRC

CONTROL OF WATER PLAN

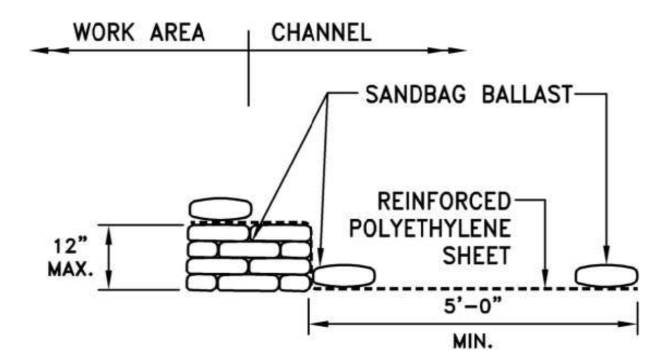
SHEET NO.: 2.0



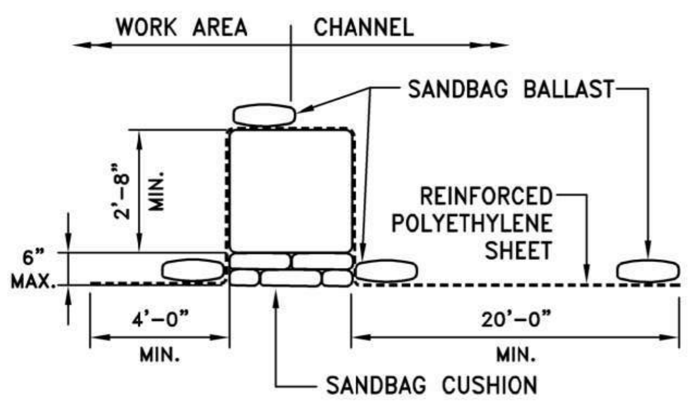
BAG CONFIGURATION "A-1"



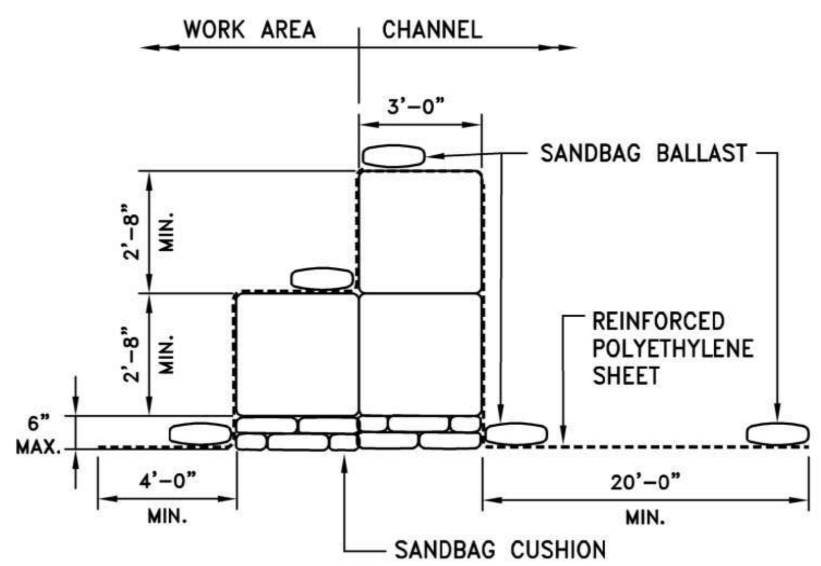
BAG CONFIGURATION "B-1"



BAG CONFIGURATION "C-1"



BAG CONFIGURATION "A-2"



BAG CONFIGURATION "B-2"

SUPER SACK DETAILS

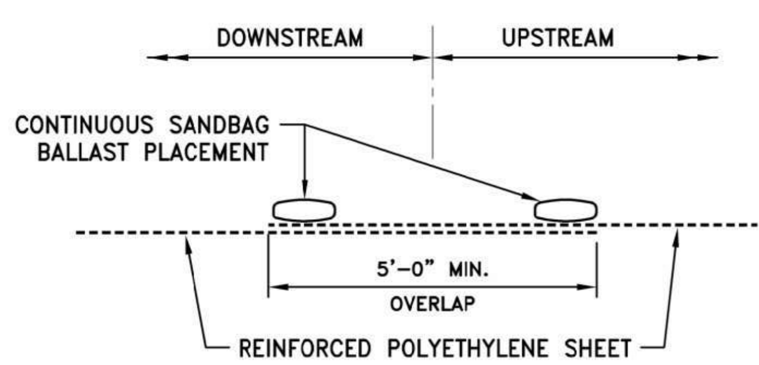
SCALE: 1/4"=1'-0"

UPSTREAM COFFERDAM CONFIGURATION TABLE	
BOTTOM OF CHANNEL ELEVATION	*BAG CONFIG.*
HIGHER THAN 822.33	A-1, A-2
HIGHER THAN 821.83	A-2
BETWEEN 821.83 & 819.66	B-1, B-2
BETWEEN 819.66 & 819.16	B-2
LOWER THAN 819.16	CONTACT PARE

DOWNSTREAM COFFERDAM CONFIGURATION TABLE	
BOTTOM OF CHANNEL ELEVATION	*BAG CONFIG.*
HIGHER THAN 821.33	A-1, A-2
HIGHER THAN 820.83	A-2
BETWEEN 820.83 & 118.66	B-1, B-2
LOWER THAN 818.66	CONTACT PARE

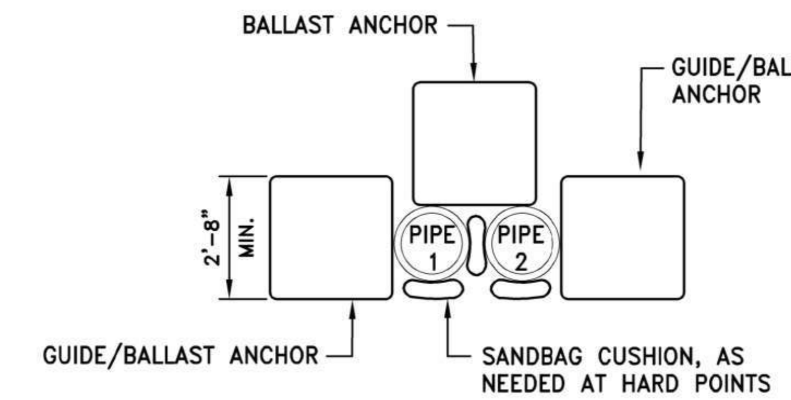
NOTES:

1. TOP OF UPSTREAM COFFERDAM TO BE EL. 825.0.
2. TOP OF DOWNSTREAM COFFERDAM EL. TO BE 824.0.
3. IF NEEDED MAS SHALL STAGGER BAG PLACEMENT SO THAT VERTICAL JOINTS BETWEEN BAGS DO NOT ALIGN.
4. BAG CONFIGURATIONS C-1 SHALL ONLY BE USED TO ISOLATE THE SPECIFIC WORK AREAS WITHIN THE UPSTREAM AND DOWNSTREAM COFFERDAM LIMITS.
5. IN THE EVENT OF AN OVERTOPPING EVENT A SINGLE BAG AS SHOWN IN A-1 OR A-2 CONFIGURATIONS MAY BE INSUFFICIENT TO RESIST CHANNEL FLOWS. TO INCREASE THE CHANCES OF THE COFFERDAM REMAINING IN PLACE A SECOND ROW OF BAGS CAN BE ADDED BEHIND THE COFFERDAM. A SECOND ROW SHOULD BE OVERLAPPED WITH POLYETHYLENE SHEETING, AS SHOWN IN THE BY-PASS PIPE INLET SECTION DETAIL..
6. SPACING BETWEEN BY-PASS PIPES AT THE INLET/OUTLET COFFERDAMS AND WITHIN DOWNSTREAM AREA SHALL BE SUFFICIENT TO ALLOW COMPACTION EQUIPMENT BETWEEN THE PIPES SO MATERIAL PLACED BETWEEN THE PIPES CAN BE ADEQUATELY COMPACTED. CLOSER PIPE SPACING IS POSSIBLE, BUT MAY REQUIRE THE PLACEMEN OF FLOWABLE FILL TO ADEQUATELY SEAL THE SPACE BENEATH THE PIPES.



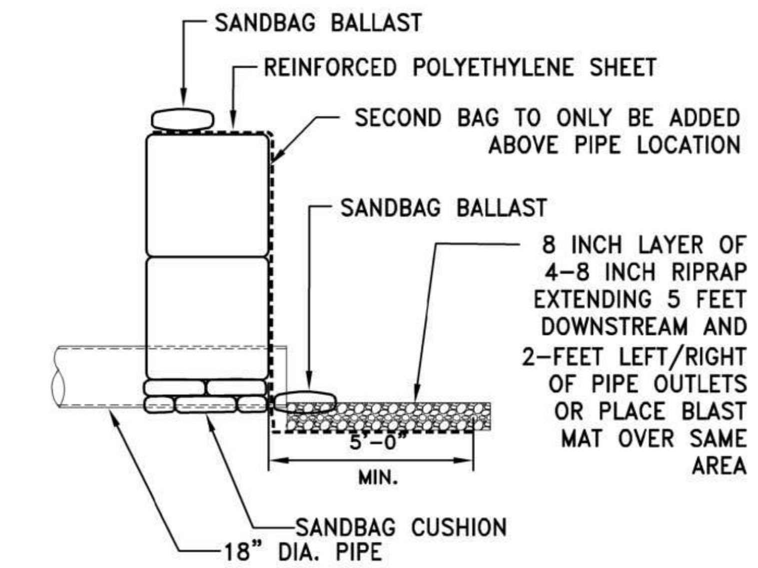
POLYETHYLENE OVERLAP DETAIL

SCALE: 1/4"=1'-0"



BY-PASS PIPE ANCHOR DETAIL

SCALE: 1/4"=1'-0"

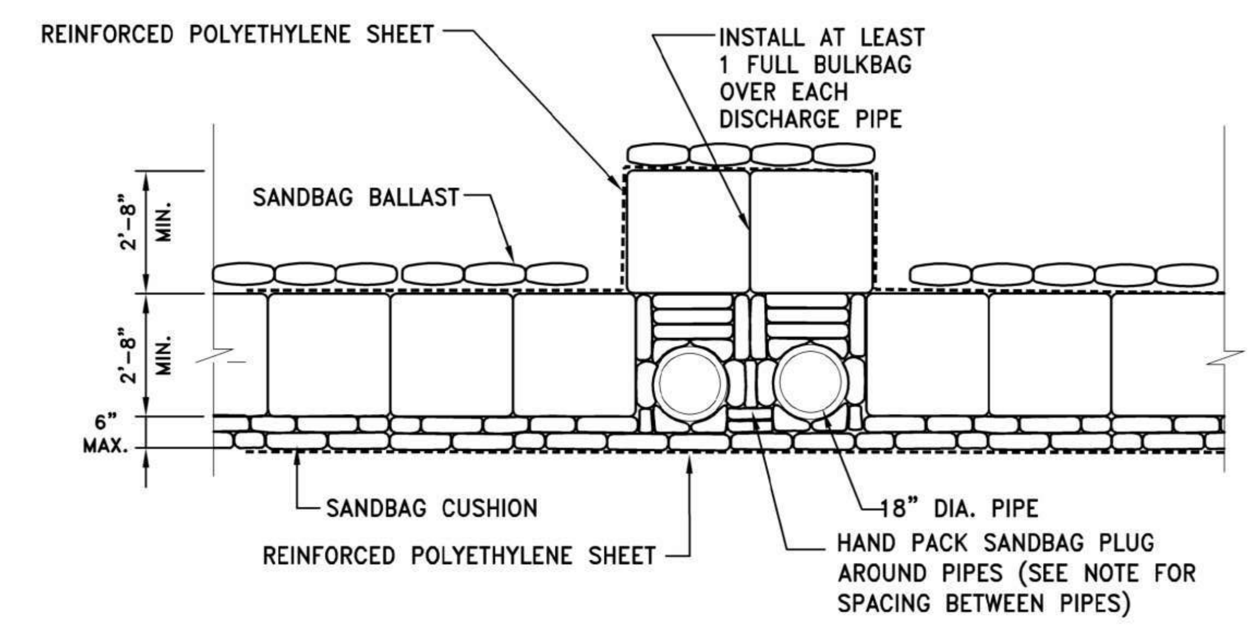


BY-PASS PIPE DISCHARGE DETAIL - FLOWING PIPE

SCALE: 1/4"=1'-0"

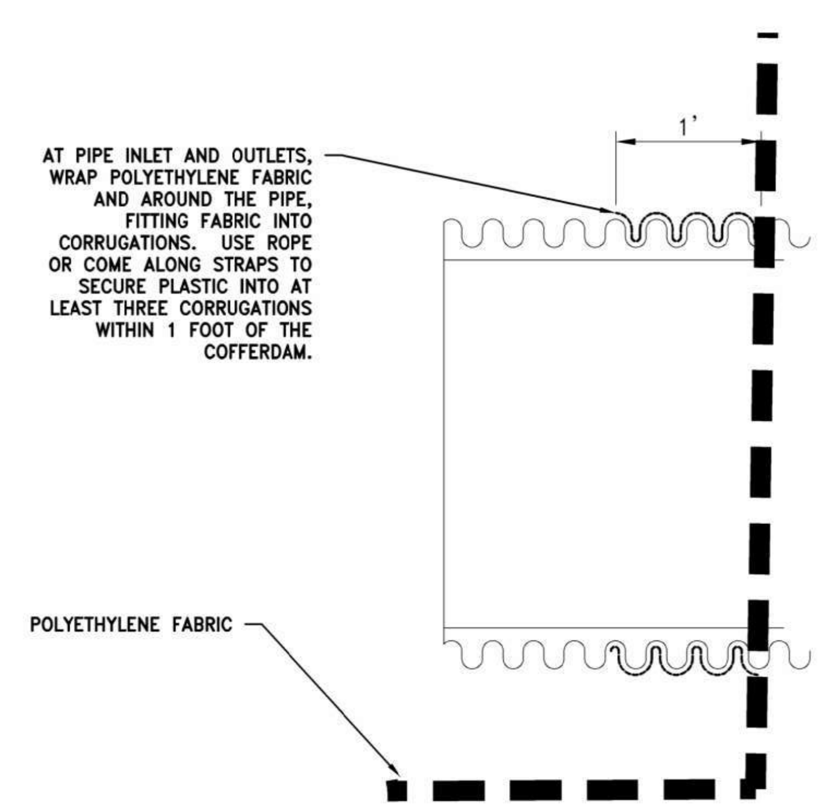
NOTES:

1. BULKBAG GUIDE ANCHORS TO BE LOCATED AT JOINTS AT NON-BURIED SECTIONS OF PIPE.
2. A SINGLE BULKBAG BALLAST ANCHOR OR 2'X2'X3' CONCRETE BLOCK ARE TO BE PLACED ON THE OUTSIDE OF PIPE BENDS, EVEN IF BURIED. ANCHORS ARE REQUIRED FOR EACH PIPE IF SPACED APART OR A SINGLE ANCHOR IF PIPES ARE IN CONTACT.
3. BOTTOM SAND BAG CUSHION OR OTHER FORM OF SUPPORT TO BE AS NEEDED AT HARD POINTS.
4. PIPE NUMBERING ASSOCIATED WITH LOOKING IN THE DOWNSTREAM DIRECTION.
5. IF CHANNEL BEDDING MEETS SCOUR RIPRAP SIZE REQUIREMENTS, ADDITIONAL SCOUR RIPRAP IS NOT REQUIRED.



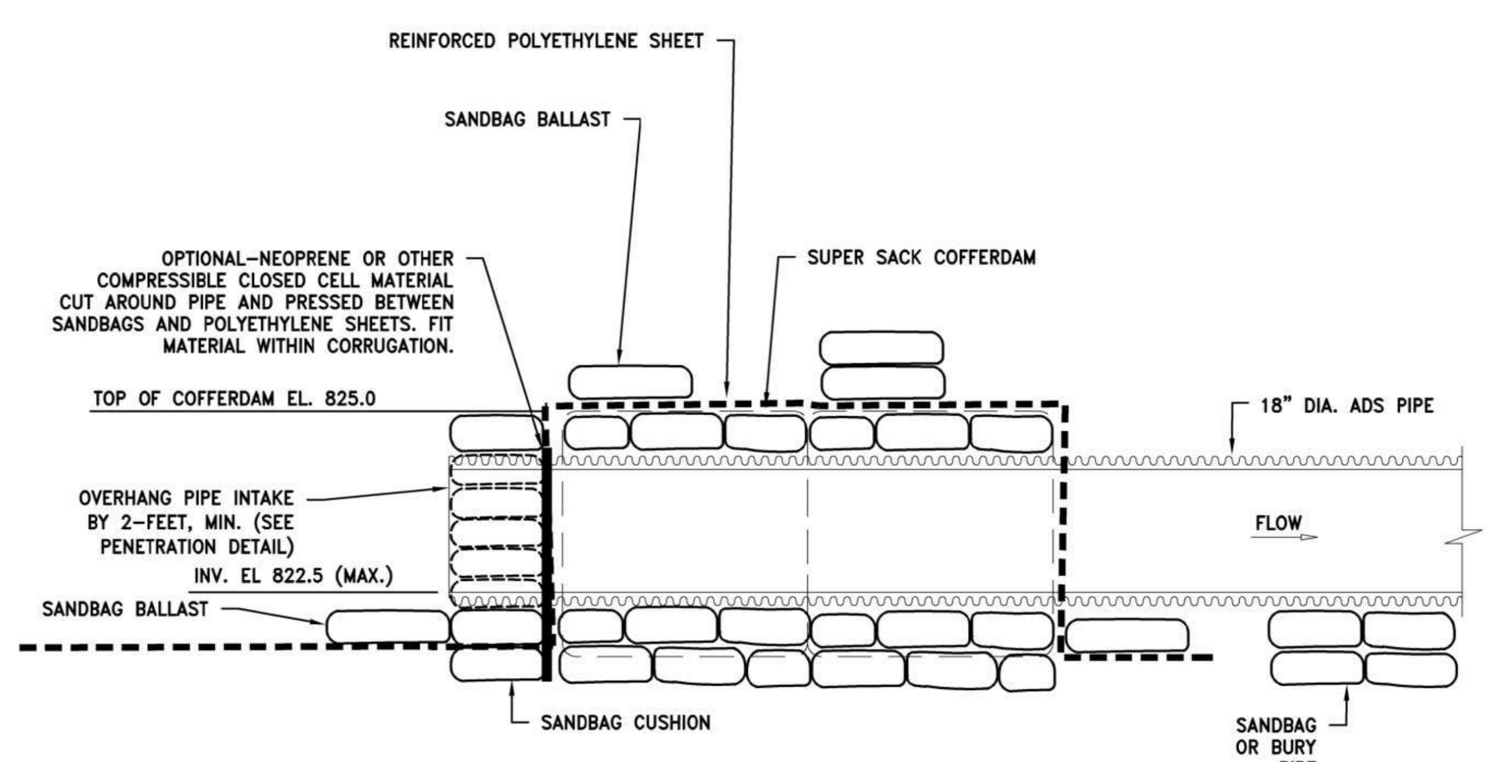
BY-PASS PIPE INTAKE/DISCHARGE PROFILE

SCALE: 1/2"=1'-0"



BY-PASS PIPE COFFERDAM PENETRATION DETAIL

SCALE: NOT TO SCALE



BY-PASS PIPE INLET SECTION

SCALE: 1/2"=1'-0"

NOTES:

1. POLYETHYLENE SHEET TO EXTEND 20-FEET BEYOND THE COFFERDAM AND TO DRAPE OVER THE COFFERDAM TO THE DOWNSTREAM TOE

FOR CONSTRUCTION

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PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
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FOXBORO, MA 02035
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SCALE ADJUSTMENT GUIDE
0" 1"
BAR IS ONE INCH ON ORIGINAL DRAWING.

LOCKS POND ROAD BRIDGE REPLACEMENT
CONTROL OF WATER AT LOCKS POND ROAD
SHUTESBURY, MASSACHUSETTS

PREPARED FOR: MAS BUILDING & BRIDGE
OWNERS:TOWN OF SHUTESBURY - DEPARTMENT OF PUBLIC WORKS

REVISIONS:

PROJECT NO.:	21139.00
DATE:	AUGUST 2021
SCALE:	AS NOTED
DESIGNED BY:	DRC
CHECKED BY:	JMB
DRAWN BY:	LMC
APPROVED BY:	DRC

COFFERDAM DETAILS

SHEET NO.: 3.0

CONTROL OF WATER
DESIGN CALCULATIONS

Calculation Cover Sheet

PARE CORPORATION

Project #: 21139.00
Project: MAS Shutesbury Control of Water
Subject/Task: Sandbag Cofferdam and pipe calculations
Status: Review
Date: 07/28/2021

Design basic:

1. Determine global stability and scour protection required for the anticipated sandbag cofferdam
2. Determine anticipated thrust force and thrust block design.

Provided:

1. Plan set of anticipated control of water (From MAS).
2. Pipe 18 inch inner diameter ADS N-12 ST IB.

General Assumptions:

1. Water Density = 62.4 lb/ft^3
2. Unit weight of sandbag material is 115 lb/ft^3
3. Interface friction angle between bags and channel floor is 38-degrees
4. 2-year design storm event will occur at elevation 826.3 with a flow rate of 244 cfs.
5. Water levels will raise gradually as to not impart an impact load on the cofferdam.

7. Burial material for pipe shall be of Class I or Class II in accordance with the requirements in technical document 2.02 provided by ADS design manual.

8.Channel floor materials are Class 8 medium dense to dense materials or better in accordance with Table 1806.2a of Chapter 18 of the Massachusetts Supplements to the IBC, capable of an allowable bearing capacity of 6000 psf.

9. Ice Loading not considered.

10. Earthquake Loading not considered.

References:

1. USGS StreamStats, https://streamstats.usgs.gov/ss/
2. Handbook of PE Pipe, Plastics Pipe Institute, Second Edition, 2008.
3. ADS Drainage Handbook
4. Technical Note 2.02, ADS, September 2008.

Results:

ADS N-12 Pipe shall be able to withstand pipe crushing conditions under H-25 loading as specified by the technical documents provided by the manufacturers. It is anticipated a double sandbag wall one sand bag high shall meet global stability requirements with scour protection during the 2 year flood event. It is anticipated a two sand bag high wall shall also meet global and internal stability requirements for the 2 year storm. The two sandbag high wall is anticipated to require greater scour protection

	Name	Position	Signature
Calculation by:	Jon Paul Nanni II	Engineer I	
Checked by:	David R Caouette	Senior Project Engineer	

SUPERSACK PARAMETERS (assumed):

$\gamma_f := 115\ pcf$	unit weight of fill
$B_l := 36\ in$	length of bag
$B_w := 36\ in$	width of bag
$B_h := 32\ in$	height of bag
$B_v := B_l \cdot B_w \cdot B_h = 24\ ft^3$	Volume of bag
$B_{wt} := B_v \cdot \gamma_f = \left(2.76 \cdot 10^3\right)\ lbf$	Weight of bag

SANDBAG PARAMETERS (assumed):

$\gamma_f := 115\ pcf$	unit weight of fill
$sb_l := 36\ in$	length of bag
$sb_w := 36\ in$	width of bag
$sb_h := 3\ in$	height of bag
$sb_v := sb_l \cdot sb_w \cdot sb_h = 2.25\ ft^3$	Volume of bag
$sb_{wt} := sb_v \cdot \gamma_f = 258.75\ lbf$	Weight of bag

typical filled sandbag length and width is 12"x18" however for ease of calculation a 36"x36" size will be assumed uniformly under the supersack.

WATER PARAMETERS (assumed):

$\gamma_w := 62.4\ pcf$	unit weight of water

GENERAL PARAMETERS (assumed):

$\phi_{bi} := 32\ deg$	Interaction angle between bags (internal stability)
$\phi_{be} := 38\ deg$	Interaction angle between bags and canal (external stability)
$FB := 0\ in$	Freeboard
$TOC := 825\ ft$	Top of Cofferdam Elevation

BAG CONFIGURATION "A-1" (GLOBAL):

Geometry

$h_{a1} := B_h = 2.667\ ft$ height of cofferdam

$w_{a1} := B_l = 3\ ft$ base width of cofferdam

$h_{wa1} := h_{a1} - FB = 2.667\ ft$ height of water

Resisting Forces

$F_{va1} := B_{wt} = \left(2.76 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fa1} := F_{va1} \cdot \tan\left(\phi_{be}\right) = \left(2.156 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

$y_{ba1} := \frac{w_{a1}}{2} = 1.5\ ft$ Moment arm

$M_{ra1} := B_{wt} \cdot y_{ba1} = \left(4.14 \cdot 10^3\right)\ lbf \cdot ft$ Resisting Moment of cofferdam

Driving Forces

$F_{da1} := 0.5 \cdot \gamma_w \cdot \left(h_{wa1}\right)^2 \cdot B_w = 665.6\ lbf$ Horizontal force of water

$y_{wa1} := \frac{h_{wa1}}{3} = 0.889\ ft$ Moment arm

$M_{oa1} := F_{da1} \cdot y_{wa1} = 591.644\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sa1} := \frac{F_{fa1}}{F_{da1}} = 3.24$ $FS_{sldа1} := \text{if}\left(FS_{sa1} \geq 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

CHECK ECCENTRICITY

$e_{a1} := \frac{w_{a1}}{2} - \frac{\left(M_{ra1} - M_{oa1}\right)}{F_{va1}} = 0.214\ ft$

check $X_{ra1} := \frac{M_{ra1} - M_{oa1}}{F_{va1}} = 1.286\ ft$

$\frac{w_{a1}}{3} = 1\ ft$

$\frac{w_{a1}}{6} = 0.5\ ft$

If e<w/6, then FS OK aganst overturning.

$eccentricity := \text{if}\left(\left|e_{a1}\right| \leq \frac{w_{a1}}{6}, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$

Overturning Resistance

$q_{ta1} := \frac{F_{va1}}{w_{a1}} \cdot \left(1 + 6 \cdot \frac{e_{a1}}{w_{a1}}\right) = \left(1.314 \cdot 10^3\right)\ plf$ pressure at toe

$FS_{ma1} := \frac{M_{ra1}}{M_{oa1}} = 7$

$q_{ha1} := \frac{F_{va1}}{w_{a1}} \cdot \left(1 - 6 \cdot \frac{e_{a1}}{w_{a1}}\right) = 525.57\ plf$ pressure at heel

BAG CONFIGURATION "A-2" (GLOBAL):

Geometry

$h_{a2} := B_h + 2 \cdot sb_h = 3.167\ ft$ height of cofferdam

$w_{a2} := B_l = 3\ ft$ base width of cofferdam

$h_{wa2} := h_{a2} - FB = 3.167\ ft$ height of water

Resisting Forces

$F_{va2} := B_{wt} + 2 \cdot sb_{wt} = \left(3.278 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fa2} := F_{va2} \cdot \tan\left(\phi_{be}\right) = \left(2.561 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

$y_{ba2} := \dfrac{w_{a2}}{2} = 1.5\ ft$ Moment arm

$M_{ra2} := B_{wt} \cdot y_{ba2} = \left(4.14 \cdot 10^3\right)\ lbf \cdot ft$ Resisting Moment of cofferdam

Driving Forces

$F_{da2} := 0.5 \cdot \gamma_w \cdot \left(h_{wa2}\right)^2 \cdot B_w = 938.6\ lbf$ Horizontal force of water

$y_{wa2} := \dfrac{h_{wa2}}{3} = 1.056\ ft$ Moment arm

$M_{oa2} := F_{da2} \cdot y_{wa2} = 990.744\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sa2} := \dfrac{F_{fa2}}{F_{da2}} = 2.73$ $FS_{slda2} := \text{if}\left(FS_{sa2} \ge 1.5, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

CHECK ECCENTRICITY

$e_{a2} := \dfrac{w_{a2}}{2} - \dfrac{\left(M_{ra2} - M_{oa2}\right)}{F_{va2}} = 0.539\ ft$ *check* $X_{ra2} := \dfrac{M_{ra2} - M_{oa2}}{F_{va2}} = 0.961\ ft$

$\dfrac{w_{a2}}{3} = 1\ ft$

$\dfrac{w_{a2}}{6} = 0.5\ ft$ If e<w/6, then FS OK aganst overturning.

Overturning Resistance

$eccentricity := \text{if}\left(\left|e_{a2}\right| \le \dfrac{w_{a2}}{6}, \text{"OK"}, \text{"NG"}\right) = \text{"NG"}$

$q_{ta2} := \dfrac{F_{va2}}{w_{a2}} \cdot \left(1 + 6 \cdot \dfrac{e_{a2}}{w_{a2}}\right) = \left(2.27 \cdot 10^3\right)\ plf$ pressure at toe

$FS_{ma2} := \dfrac{M_{ra2}}{M_{oa2}} = 4.18$

$q_{ha2} := \dfrac{F_{va2}}{w_{a2}} \cdot \left(1 - 6 \cdot \dfrac{e_{a2}}{w_{a2}}\right) = -85.496\ plf$ pressure at heel

BAG CONFIGURATION "B-1" (GLOBAL):

Geometry

$h_{b1} := 2 \cdot B_h = 5.333\ ft$ height of cofferdam

$w_{b1} := 2 \cdot B_l = 6\ ft$ base width of cofferdam

$h_{wb1} := h_{b1} - FB = 5.333\ ft$ height of water

Resisting Forces

$F_{vb1} := 3 \cdot B_{wt} = \left(8.28 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fb1} := F_{vb1} \cdot \tan\left(\phi_{be}\right) = \left(6.469 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

$M_{rb1} := B_{wt} \cdot \left(\frac{B_w}{2} + \left(B_w + \frac{B_w}{2}\right) + \left(\frac{w_{b1}}{2}\right)\right) = \left(2.484 \cdot 10^4\right)\ lbf \cdot ft$ Resisting Moment of cofferdam

Driving Forces

$F_{db1} := 0.5 \cdot \gamma_w \cdot \left(h_{wb1}\right)^2 \cdot B_l = \left(2.662 \cdot 10^3\right)\ lbf$ Horizontal force of water

$y_{wb1} := \frac{h_{wb1}}{3} = 1.778\ ft$ Moment arm

$M_{ob1} := F_{db1} \cdot y_{wb1} = \left(4.733 \cdot 10^3\right)\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sb1} := \frac{F_{fb1}}{F_{db1}} = 2.43$ $FS_{sldb1} := \text{if}\left(FS_{sb1} \geq 1.5, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

CHECK ECCENTRICITY

$e_{b1} := \frac{w_{b1}}{2} - \frac{\left(M_{rb1} - M_{ob1}\right)}{F_{vb1}} = 0.572\ ft$

check $X_{rb1} := \frac{M_{rb1} - M_{ob1}}{F_{vb1}} = 2.428\ ft$

$\frac{w_{b1}}{3} = 2\ ft$

$\frac{w_{b1}}{6} = 1\ ft$

If e<w/6, then FS OK aganst overturning.

Overturning Resistance

$eccentricity := \text{if}\left(\left|e_{b1}\right| \leq \frac{w_{b1}}{6}, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

$q_{tb1} := \frac{F_{vb1}}{w_{b1}} \cdot \left(1 + 6 \cdot \frac{e_{b1}}{w_{b1}}\right) = \left(2.169 \cdot 10^3\right)\ plf$ pressure at toe

$FS_{mb1} := \frac{M_{rb1}}{M_{ob1}} = 5.25$

$q_{hb1} := \frac{F_{vb1}}{w_{b1}} \cdot \left(1 - 6 \cdot \frac{e_{b1}}{w_{b1}}\right) = 591.141\ plf$ pressure at heel

BAG CONFIGURATION "B-2" (GLOBAL):

Geometry

$h_{b2} := 2 \cdot B_h + 2 \cdot sb_h = 5.833\ ft$ height of cofferdam

$w_{b2} := 2 \cdot B_l = 6\ ft$ base width of cofferdam

$h_{wb2} := h_{b2} - FB = 5.833\ ft$ height of water

Resisting Forces

$F_{vb2} := 3 \cdot B_{wt} + 2 \cdot sb_{wt} = (8.798 \cdot 10^3)\ lbf$ Weight of cofferdam

$F_{fb2} := F_{vb2} \cdot \tan(\phi_{be}) = (6.873 \cdot 10^3)\ lbf$ Sliding Friction of cofferdam

$$M_{rb2} := B_{wt} \cdot \left(\frac{B_w}{2} + \left(B_w + \frac{B_w}{2}\right) + \left(\frac{w_{b2}}{2}\right)\right) + 2 \cdot sb_{wt} \cdot \left(\frac{w_{b2}}{2}\right) = (2.639 \cdot 10^4)\ lbf \cdot ft$$ Resisting Moment of cofferdam

Driving Forces

$F_{db2} := 0.5 \cdot \gamma_w \cdot (h_{wb2})^2 \cdot B_l = (3.185 \cdot 10^3)\ lbf$ Horizontal force of water

$y_{wb2} := \frac{h_{wb2}}{3} = 1.944\ ft$ Moment arm

$M_{ob2} := F_{db2} \cdot y_{wb2} = (6.193 \cdot 10^3)\ lbf \cdot ft$ Overturning Moment of water

Sliding Resistance

$FS_{sb2} := \frac{F_{fb2}}{F_{db2}} = 2.16$ $FS_{sldb2} := \text{if}\left(FS_{sb2} \ge 1.5, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

CHECK ECCENTRICITY

$e_{b2} := \frac{w_{b2}}{2} - \frac{(M_{rb2} - M_{ob2})}{F_{vb2}} = 0.704\ ft$ *check* $X_{rb2} := \frac{M_{rb2} - M_{ob2}}{F_{vb2}} = 2.296\ ft$

$\frac{w_{b2}}{6} = 1\ ft$ If e<w/6, then FS OK aganst overturning. $\frac{w_{b2}}{3} = 2\ ft$

Overturning Resistance

$eccentricity := \text{if}\left(\left|e_{b2}\right| \le \frac{w_{b2}}{6}, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

$q_{tb2} := \frac{F_{vb2}}{w_{b2}} \cdot \left(1 + 6 \cdot \frac{e_{b2}}{w_{b2}}\right) = (2.498 \cdot 10^3)\ plf$ pressure at toe

$FS_{mb2} := \frac{M_{rb2}}{M_{ob2}} = 4.26$

$q_{hb2} := \frac{F_{vb2}}{w_{b2}} \cdot \left(1 - 6 \cdot \frac{e_{b2}}{w_{b2}}\right) = 434.074\ plf$ pressure at heel

BAG CONFIGURATION "A-1" (Internal): This applies for the internal stability of the top bag for Configurations A-2, B-1, B-2.

Geometry

$h_{a1} := B_h = 2.667\ ft$ height of cofferdam

$w_{a1} := B_l = 3\ ft$ base width of cofferdam

$h_{wa1} := h_{a1} - FB = 2.667\ ft$ height of water

Resisting Forces

$F_{va1} := B_{wt} = \left(2.76 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fa1i} := F_{va1} \cdot \tan\left(\phi_{bi}\right) = \left(1.725 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

Driving Forces

$F_{da1i} := 0.5 \cdot \gamma_w \cdot \left(h_{wa1}\right)^2 \cdot B_w = 665.6\ lbf$ Horizontal force of water

Internal Sliding Resistance

$$FS_{sa1i} := \frac{F_{fa1i}}{F_{da1i}} = 2.59 \qquad FS_{slda1i} := \text{if}\left(FS_{sa1i} \geq 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$$

BAG CONFIGURATION "B-1" (Internal): This applies for the internal stability of the top bag for Configurations B-2, C-1 and C-2.

Geometry

$h_{b1} := 2 \cdot B_h = 5.333\ ft$ height of cofferdam

$w_{b1} := 2 \cdot B_l = 6\ ft$ base width of cofferdam

$h_{wb1} := h_{b1} - FB = 5.333\ ft$ height of water

Resisting Forces

$F_{vb1} := 3 \cdot B_{wt} = \left(8.28 \cdot 10^3\right)\ lbf$ Weight of cofferdam

$F_{fb1i} := F_{vb1} \cdot \tan\left(\phi_{bi}\right) = \left(5.174 \cdot 10^3\right)\ lbf$ Sliding Friction of cofferdam

Driving Forces

$F_{db1i} := 0.5 \cdot \gamma_w \cdot \left(h_{wb1}\right)^2 \cdot B_l = \left(2.662 \cdot 10^3\right)\ lbf$ Horizontal force of water

Sliding Resistance

$$FS_{sb1i} := \frac{F_{fb1i}}{F_{db1i}} = 1.94 \qquad FS_{sldb1i} := \text{if}\left(FS_{sb1i} \geq 1.5, \text{“OK”}, \text{“NG”}\right) = \text{“OK”}$$

SUMMARY OF COFFERDAM RESULTS:

Configuration	F.S. Sliding	F.S. Overturning	Eccentricity	Max. Bearing Pressure
A-1	$FS_{sa1} = 3.24$	$FS_{ma1} = 6.997$		$q_{ta1} = \left(1.314 \cdot 10^3\right)$ *plf*
A-2	$FS_{sa2} = 2.728$	$FS_{ma2} = 4.179$		$q_{ta2} = \left(2.27 \cdot 10^3\right)$ *plf*
B-1	$FS_{sb1} = 2.43$	$FS_{mb1} = 5.248$	Within middle third for all configurations	$q_{tb1} = \left(2.169 \cdot 10^3\right)$ *plf*
B-2	$FS_{sb2} = 2.158$	$FS_{mb2} = 4.262$		$q_{tb2} = \left(2.498 \cdot 10^3\right)$ *plf*
A-1 internal	$FS_{sa1i} = 2.591$	Same as external		Same as external
B-1 internal	$FS_{sb1i} = 1.943$	Same as external		Same as external

Configuration	Min. / Max. Bearing Pressure		Lowest Allowable Bottom El.
A-1	$q_{ha1} = 525.57$ *plf*	$q_{ta1} = \left(1.314 \cdot 10^3\right)$ *plf*	$BOT_{a1} := TOC - h_{a1} = 822.333$ *ft*
A-2	$q_{ha2} = -85.496$ *plf*	$q_{ta2} = \left(2.27 \cdot 10^3\right)$ *plf*	$BOT_{a2} := TOC - h_{a2} = 821.833$ *ft*
B-1	$q_{hb1} = 591.141$ *plf*	$q_{tb1} = \left(2.169 \cdot 10^3\right)$ *plf*	$BOT_{b1} := TOC - h_{b1} = 819.667$ *ft*
B-2	$q_{hb2} = 434.074$ *plf*	$q_{tb2} = \left(2.498 \cdot 10^3\right)$ *plf*	$BOT_{b2} := TOC - h_{b2} = 819.167$ *ft*

Summary for Pond 79P: 2x18 inch TOC @825.0, 2-yr storm

[58] Hint: Peaked 807.08' above defined flood level

Inflow	=	244.00 cfs @	0.00 hrs, Volume=	1,452.909 af,	Incl. 244.00 cfs Base Flow
Outflow	=	244.00 cfs @	0.00 hrs, Volume=	1,452.909 af,	Atten= 0%, Lag= 0.0 min
Primary	=	15.82 cfs @	0.00 hrs, Volume=	94.186 af	
Secondary	=	228.18 cfs @	0.00 hrs, Volume=	1,358.723 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 826.35' @ 0.00 hrs
Flood Elev= 19.27'

Device	Routing	Invert	Outlet Devices
#1	Primary	822.50'	**18.0" Round Culvert X 2.00** L= 263.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0038 '/' Cc= 1.000 n= 0.010 PVC, smooth interior, Flow Area= 1.77 sf
#2	Secondary	825.00'	**45.0' long (Profile 17) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 Coef. (English) 2.84 3.13 3.26 3.30 3.31 3.31

Primary OutFlow Max=15.82 cfs @ 0.00 hrs HW=826.35' TW=825.00' (Fixed TW Elev= 825.00')
└─**1=Culvert** (Outlet Controls 15.82 cfs @ 4.48 fps)

Secondary OutFlow Max=228.18 cfs @ 0.00 hrs HW=826.35' TW=825.00' (Fixed TW Elev= 825.00')
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 228.18 cfs @ 3.75 fps)

Stage-Discharge for Pond 79P: 2x18 inch TOC @825.0, 2-yr storm

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
822.50	0.00	0.00	0.00
822.55	0.00	0.00	0.00
822.60	0.00	0.00	0.00
822.65	0.00	0.00	0.00
822.70	0.00	0.00	0.00
822.75	0.00	0.00	0.00
822.80	0.00	0.00	0.00
822.85	0.00	0.00	0.00
822.90	0.00	0.00	0.00
822.95	0.00	0.00	0.00
823.00	0.00	0.00	0.00
823.05	0.00	0.00	0.00
823.10	0.00	0.00	0.00
823.15	0.00	0.00	0.00
823.20	0.00	0.00	0.00
823.25	0.00	0.00	0.00
823.30	0.00	0.00	0.00
823.35	0.00	0.00	0.00
823.40	0.00	0.00	0.00
823.45	0.00	0.00	0.00
823.50	0.00	0.00	0.00
823.55	0.00	0.00	0.00
823.60	0.00	0.00	0.00
823.65	0.00	0.00	0.00
823.70	0.00	0.00	0.00
823.75	0.00	0.00	0.00
823.80	0.00	0.00	0.00
823.85	0.00	0.00	0.00
823.90	0.00	0.00	0.00
823.95	0.00	0.00	0.00
824.00	0.00	0.00	0.00
824.05	0.00	0.00	0.00
824.10	0.00	0.00	0.00
824.15	0.00	0.00	0.00
824.20	0.00	0.00	0.00
824.25	0.00	0.00	0.00
824.30	0.00	0.00	0.00
824.35	0.00	0.00	0.00
824.40	0.00	0.00	0.00
824.45	0.00	0.00	0.00
824.50	0.00	0.00	0.00
824.55	0.00	0.00	0.00
824.60	0.00	0.00	0.00
824.65	0.00	0.00	0.00
824.70	0.00	0.00	0.00
824.75	0.00	0.00	0.00
824.80	0.00	0.00	0.00
824.85	0.00	0.00	0.00
824.90	0.00	0.00	0.00
824.95	0.00	0.00	0.00
825.00	0.00	0.00	0.00
825.05	4.47	3.04	1.43
825.10	8.34	4.30	4.04
825.15	12.69	5.27	7.42
825.20	17.52	6.08	11.43
825.25	22.78	6.80	15.97
825.30	28.45	7.45	21.00
825.35	34.51	8.05	26.46
825.40	40.94	8.60	32.33
825.45	47.71	9.13	38.58
825.50	54.90	9.62	45.28
825.55	62.87	10.09	52.78
825.60	71.30	10.54	60.76
825.65	80.18	10.97	69.21
825.70	89.51	11.38	78.12
825.75	99.29	11.78	87.51
825.80	109.52	12.17	97.35
825.85	120.21	12.54	107.67
825.90	131.35	12.91	118.44
825.95	142.94	13.26	129.68
826.00	154.69	13.61	141.08
826.05	166.37	13.94	152.43
826.10	178.39	14.27	164.12
826.15	190.74	14.59	176.15
826.20	203.44	14.90	188.54
826.25	216.47	15.21	201.26
826.30	229.83	15.51	214.32
826.35	**243.53**	**15.81**	**227.72**

During a 2 year storm event tailwater conditions limit discharge flows below elevation 825.00

Summary for Pond 78P: 2x18 inch TOC @825.0, 19cfs

[58] Hint: Peaked 805.73' above defined flood level

Inflow	=	19.00 cfs @	0.00 hrs,	Volume=	113.136 af,	Incl. 19.00 cfs Base Flow
Outflow	=	19.00 cfs @	0.00 hrs,	Volume=	113.136 af,	Atten= 0%, Lag= 0.0 min
Primary	=	19.00 cfs @	0.00 hrs,	Volume=	113.136 af	
Secondary	=	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 825.00' @ 0.00 hrs
Flood Elev= 19.27'

Device	Routing	Invert	Outlet Devices
#1	Primary	822.50'	**18.0" Round Culvert X 2.00** L= 273.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 822.50' / 821.50' S= 0.0037 '/' Cc= 1.000 n= 0.010 PVC, smooth interior, Flow Area= 1.77 sf
#2	Secondary	825.00'	**45.0' long (Profile 17) Broad-Crested Rectangular Weir** Head (feet) 0.49 0.98 1.48 1.97 2.46 2.95 Coef. (English) 2.84 3.13 3.26 3.30 3.31 3.31

Primary OutFlow Max=19.00 cfs @ 0.00 hrs HW=825.00' TW=821.50' (Fixed TW Elev= 821.50')
↑—**1=Culvert** (Barrel Controls 19.00 cfs @ 5.38 fps)

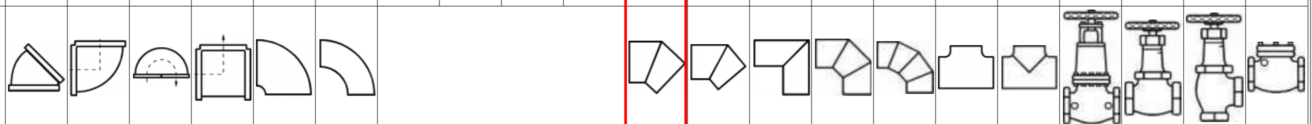
Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=825.00' TW=821.50' (Fixed TW Elev= 821.50')
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Stage-Discharge for Pond 78P: 2x18 inch TOC @825.0, 19cfs

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
822.50	0.00	0.00	**0.00**
822.55	0.02	0.02	0.00
822.60	0.08	0.08	0.00
822.65	0.19	0.19	0.00
822.70	0.34	0.34	0.00
822.75	0.54	0.54	0.00
822.80	0.78	0.78	0.00
822.85	1.06	1.06	0.00
822.90	1.39	1.39	0.00
822.95	1.75	1.75	0.00
823.00	2.15	2.15	0.00
823.05	2.57	2.57	0.00
823.10	3.03	3.03	0.00
823.15	3.52	3.52	0.00
823.20	4.03	4.03	0.00
823.25	4.57	4.57	0.00
823.30	5.12	5.12	0.00
823.35	5.70	5.70	0.00
823.40	6.29	6.29	0.00
823.45	6.90	6.90	0.00
823.50	7.51	7.51	0.00
823.55	8.14	8.14	0.00
823.60	8.77	8.77	0.00
823.65	9.41	9.41	0.00
823.70	10.04	10.04	0.00
823.75	10.68	10.68	0.00
823.80	11.31	11.31	0.00
823.85	11.93	11.93	0.00
823.90	12.55	12.55	0.00
823.95	13.15	13.15	0.00
824.00	13.73	13.73	0.00
824.05	14.28	14.28	0.00
824.10	14.81	14.81	0.00
824.15	15.31	15.31	0.00
824.20	15.77	15.77	0.00
824.25	16.18	16.18	0.00
824.30	16.53	16.53	0.00
824.35	16.80	16.80	0.00
824.40	16.98	16.98	0.00
824.45	17.00	17.00	0.00
824.50	16.46	16.46	0.00
824.55	16.73	16.73	0.00
824.60	17.00	17.00	0.00
824.65	17.26	17.26	0.00
824.70	17.52	17.52	0.00
824.75	17.78	17.78	0.00
824.80	18.03	18.03	0.00
824.85	18.28	18.28	0.00
824.90	18.52	18.52	0.00
824.95	18.77	18.77	0.00
825.00	**19.01**	**19.01**	0.00

Capacity just prior to overtopping.

Equivalent resistence of bends, fittings, and valves, length of straight pipe in feet *

		Screwed fittings				90° welding elbows & smooth bends							Miter elbows (No. of miters)				Welding tees		Valves (screwed, flanged, or welded)			
		45° ell	90° ell	180° close return bends	Tee	R/d = 1	R/d =1-1/2	R/d = 2	R/d = 4	R/d = 6	R/d = 8	1-45°	1-60°	1-90°	2-90°	3-90°	Forged	Miter	Gate	Globe	Angle	Swing Check
k factor =		0.42	0.90	2.00	1.80	0.48	0.36	0.27	0.21	0.27	0.36	0.45	0.90	1.80	0.60	0.45	1.35	1.80	0.21	10	5.0	2.5
L/d' ratio n =		14	30	67	60	16	12	9	7	9	12	15	30	60	20	15	45	60	7	333	167	83
Nom. Pipe Size (inches)	Inside diam. d (inches) Sched. 40																					
		L = equivalent length in feet of schedule 40 (standard weight) straight pipe																				
1/2	0.622	0.73	1.55	3.47	3.10	0.83	0.62	0.47	0.36	0.47	0.62	0.78	1.55	3.10	1.04	0.78	2.33	3.10	0.36	17.3	8.65	4.32
3/4	0.824	0.96	2.06	4.60	4.12	1.10	0.82	0.62	0.48	0.62	0.82	1.03	2.06	4.12	1.37	1.03	3.09	4.12	0.48	22.9	11.4	5.72
1	1.049	1.22	2.62	5.82	5.24	1.40	1.05	0.79	0.61	0.79	1.05	1.31	2.62	5.24	1.75	1.31	3.93	5.24	0.61	29.1	14.6	7.27
1-1/4	1.380	1.61	3.45	7.66	6.90	1.84	1.38	1.03	0.81	1.03	1.38	1.72	3.45	6.90	2.30	1.72	5.17	6.90	0.81	38.3	19.1	9.58
1-1/2	1.610	1.88	4.02	8.95	8.04	2.14	1.61	1.21	0.94	1.21	1.61	2.01	4.02	8.04	2.68	2.01	6.04	8.04	0.94	44.7	22.4	11.2
2	2.067	2.41	5.17	11.5	10.3	2.76	2.07	1.55	1.21	1.55	2.07	2.58	5.17	10.3	3.45	2.58	7.75	10.3	1.21	57.4	28.7	14.4
2-1/2	2.469	2.88	6.16	13.7	12.3	3.29	2.47	1.85	1.44	1.85	2.47	3.08	6.16	12.3	4.11	3.08	9.25	12.3	1.44	68.5	34.3	17.1
3	3.068	3.58	7.67	17.1	15.3	4.09	3.07	2.30	1.79	2.30	3.07	3.84	7.67	15.3	5.11	3.84	11.5	15.3	1.79	85.2	42.6	21.3
4	4.026	4.70	10.1	22.4	20.2	5.37	4.03	3.02	2.35	3.02	4.03	5.04	10.1	20.2	6.71	5.04	15.1	20.2	2.35	112.0	56.0	28.0
5	5.047	5.88	12.6	28.0	25.2	6.72	5.05	3.78	2.94	3.78	5.05	6.30	12.6	25.2	8.40	6.30	18.9	25.2	2.94	140.0	70.0	35.0
6	6.065	7.07	15.2	33.8	30.4	8.09	6.07	4.55	3.54	4.55	6.07	7.58	15.2	30.4	10.1	7.58	22.8	30.4	3.54	168.0	84.1	42.1
8	7.981	9.31	20.0	44.6	40.0	10.6	7.98	5.98	4.65	5.98	7.98	9.97	20.0	40.0	13.3	9.97	29.9	40.0	4.65	222.0	111.0	55.5
10	10.02	11.7	25.0	55.7	50.0	13.3	10.0	7.51	5.85	7.51	10.0	12.5	25.0	50.0	16.7	12.5	37.6	50.0	5.85	278.0	139.0	69.5
12	11.94	13.9	29.8	66.3	59.6	15.9	11.9	8.95	6.96	8.95	11.9	14.9	29.8	59.6	19.9	14.9	44.8	59.6	6.96	332.0	166.0	83.0
14	13.13	15.3	32.8	73.0	65.6	17.5	13.1	9.85	7.65	9.85	13.1	16.4	32.8	65.6	21.9	16.4	49.2	65.6	7.65	364.0	182.0	91.0
16	15.00	17.5	37.5	83.5	75.0	20.0	15.0	11.2	8.75	11.2	15.0	18.8	37.5	75.0	25.0	18.8	56.2	75.0	8.75	417.0	208.0	104.0
18	16.88	19.7	42.1	93.8	84.2	22.5	16.9	12.7	9.85	12.7	16.9	21.1	42.1	84.2	28.1	21.1	63.2	84.2	9.85	469.0	234.0	117.0
20	18.81	22.0	47.0	105.0	94.0	25.1	18.8	14.1	11.0	14.1	18.8	23.5	47.0	94.0	31.4	23.5	70.6	94.0	11.0	522.0	261.0	131.0
24	22.63	26.4	56.6	126.0	113.0	30.2	22.6	17.0	13.2	17.0	22.6	28.3	56.6	113.0	37.8	28.3	85.0	113.0	13.2	629.0	314.0	157.0

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FLOW DATA THROUGH MUELLER SERVICE MATERIALS EXPRESSED AS EQUIVALENT LENGTHS OF STRAIGHT PIPE

Size	Fitting	Equivalent Length in Feet	
		Sched. 40 Steel	Type K Copper
1/2"	Corp. Stop	9.16	6.12
3/4"	Corp. Stop	6.08	5.86
1"	Corp. Stop	5.86	6.67
1-1/4"	Corp. Stop	8.16	7.46
1-1/2"	Corp. Stop	7.82	7.70
2"	Corp. Stop	7.48	8.38
1/2"	CurbStop	4.73	3.14
3/4"	CurbStop	3.55	4.04
1"	CurbStop	3.37	3.85
1-1/4"	CurbStop	4.08	3.56
1-1/2"	CurbStop	4.43	4.43
2"	-	4.38	4.79
5/8"	H- 10890- 10891 Meter Coupling	.69	.28
3/4"	H- 10890- 10891 Meter Coupling	1.28	.89
5/8"	H- 10892 Meter Coupling	2.48**	1.22**
3/4"	H- 10892 Meter Coupling	1.70	1.09

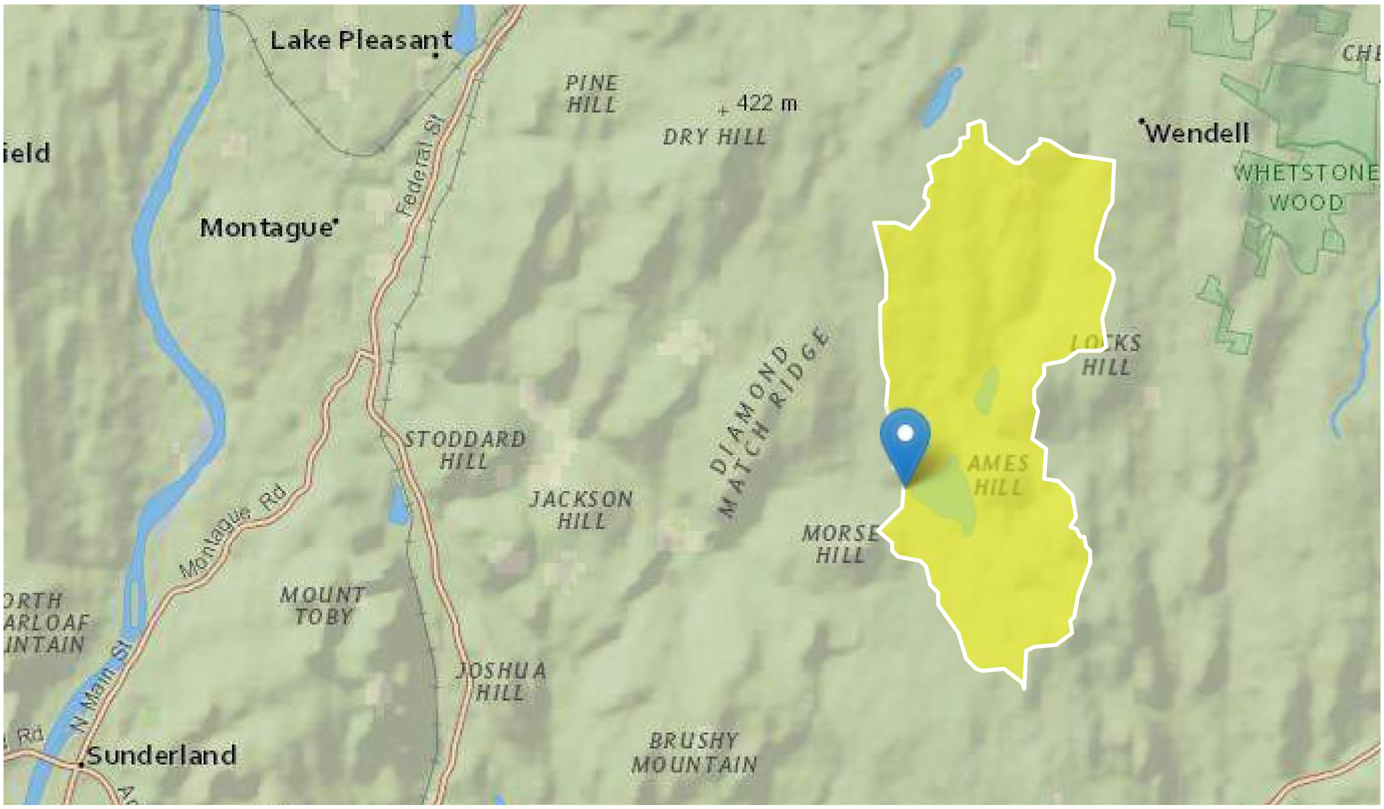
Size	Meter Yokes Catalog Number	Riser	Equivalent Length in Feet	
			Sched. 40 Steel	Type K Copper
5/8" x 3/4"	H-14111	-	7.8	5.65
5/8" x 3/4"	H- 14121	-	8.33	5.96
5/8" x 3/4"	H- 14026	9"	15.35	12.80
5/8" x 3/4"	H- 14020	9"	10.20	7.18
5/8" x 3/4"	H- 14020	15"	11.30	7.92
5/8" x 3/4"	H- 14020	18"	14.60	10.20
5/8" x 3/4"	H- 14090	20"	12.50	9.15
5/8" x 3/4"	H- 10840	-	11.50	7.83

** Referred to 1/2" Pipe.

NOTE. Only a partial list of Mueller Meter Yokes are in above list. Generally a flat allowance of 10 feet of pipe is adequate for any Meter Yoke as few services are designed with narrow friction allowances.

StreamStats Report

Region ID: MA
Workspace ID: MA20210722201451223000
Clicked Point (Latitude, Longitude): 42.50169, -72.43782
Time: 2021-07-22 16:15:09 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	6.85	square miles
ELEV	Mean Basin Elevation	992	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	8	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	4.05	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.17	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	1	dimensionless

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	8.134	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	29.65	percent
FOREST	Percentage of area covered by forest	79.97	percent

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.85	square miles	0.16	512
ELEV	Mean Basin Elevation	992	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	8	percent	0	32.3

Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	ASEp
50-percent AEP flood	244	ft^3/s	122	486	42.3
20-percent AEP flood	411	ft^3/s	203	831	43.4
10-percent AEP flood	548	ft^3/s	264	1140	44.7
4-percent AEP flood	751	ft^3/s	350	1610	47.1
2-percent AEP flood	923	ft^3/s	416	2050	49.4
1-percent AEP flood	1110	ft^3/s	484	2550	51.8
0.5-percent AEP flood	1310	ft^3/s	554	3100	54.1
0.2-percent AEP flood	1610	ft^3/s	648	4000	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.85	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	4.05	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	1	dimensionless	0	1

Low-Flow Statistics Flow Report [Statewide Low Flow WRIR00 4135]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	ASEp
7 Day 2 Year Low Flow	1.14	ft^3/s	0.395	3.17	49.5	49.5
7 Day 10 Year Low Flow	0.605	ft^3/s	0.164	2.08	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.85	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	1	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	4.05	percent	0.32	24.6

Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	ASEp
50 Percent Duration	6.8	ft^3/s	3.61	12.7	17.6	17.6
60 Percent Duration	4.9	ft^3/s	2.56	9.34	19.8	19.8
70 Percent Duration	3.94	ft^3/s	1.7	9.05	23.5	23.5
75 Percent Duration	3.32	ft^3/s	1.45	7.51	25.8	25.8
80 Percent Duration	2.87	ft^3/s	1.26	6.43	28.4	28.4
85 Percent Duration	2.26	ft^3/s	0.95	5.28	31.9	31.9
90 Percent Duration	1.82	ft^3/s	0.741	4.37	36.6	36.6
95 Percent Duration	1.17	ft^3/s	0.425	3.11	45.6	45.6
98 Percent Duration	0.832	ft^3/s	0.257	2.55	60.3	60.3
99 Percent Duration	0.632	ft^3/s	0.184	2.04	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters [Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.85	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	4.05	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.17	square mile per mile	0	1.29
MAREGION	Massachusetts Region	1	dimensionless	0	1

August Flow-Duration Statistics Flow Report [Statewide Low Flow WRIR00 4135]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	ASEp
August 50 Percent Duration	2.5	ft^3/s	1.01	6.09	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters [Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.85	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	8.134	percent	2.2	23.9

Bankfull Statistics Flow Report [Bankfull Statewide SIR2013 5155]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
Bankfull Width	32.8	ft	21.3
Bankfull Depth	1.68	ft	19.8
Bankfull Area	54.9	ft^2	29
Bankfull Streamflow	175	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters [Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	6.85	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	29.65	percent	0	100
FOREST	Percent Forest	79.97	percent	0	100
MAREGION	Massachusetts Region	1	dimensionless	0	1

Probability Statistics Disclaimers [Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Probability Statistics Flow Report [Perennial Flow Probability]

Statistic	Value	Unit
Probability Stream Flowing Perennially	0.981	dim

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

Application Version: 4.6.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.1.2

DETERMINE THRUST IN PIPES AT BENDS & REQUIRED BALLAST

$\phi_{map} := 45\ deg$ maximum angle of pipe bend on turn (2x22.5-degree)

$\gamma_w := 62.4\ \frac{lb}{ft^3}$ unit weight of water

$El_w := 827.5\ ft$ maximum elevation of water upstream

$El_p := 821.5\ ft$ elevation of pipe invert

$d_{pipe} := 18\ in$ inside diameter of pipe

$A_{pipe} := \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 = 1.767\ ft^2$ flow area in pipe (full)

$OD := 22\ in$ outside diameter of pipe

$D_{cover} := 5\ ft$ depth of cover

$Q_p := 15.0\ \frac{ft^3}{s}$ Flow rate of single pipe

$V_p := \frac{Q_p}{A_{pipe}} = 8.488\ \frac{ft}{s}$ Velocity within pipe

$P_p := \gamma_w \cdot \left(El_w - El_p\right) = 374.4\ \frac{lb}{ft^2}$ $P_p = 2.6\ \frac{lb}{in^2}$ Pressure in pipe from water

Force from Flow

$R_{xp} := \gamma_w \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot V_p^{\,2} \cdot \left(1 - \cos\left(\phi_{map}\right)\right) = 72.327\ lbf$ x-direction velocity force within pipe

$R_{yp} := \gamma_w \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot V_p^{\,2} \cdot \left(\sin\left(\phi_{map}\right)\right) = 174.612\ lbf$ y-direction velocity force within pipe

Force from Pressure

$R_{xpr} := P_p \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot \left(1 - \cos\left(\phi_{map}\right)\right) \cdot 32.2\ \frac{ft}{s^2} = 193.94\ lbf$ x-direction pressure force within pipe

$R_{ypr} := P_p \cdot \pi \cdot \left(\frac{d_{pipe}}{2}\right)^2 \cdot \left(\sin\left(\phi_{map}\right)\right) \cdot 32.2\ \frac{ft}{s^2} = 468.213\ lbf$ y-direction pressure force within pipe

Sum of All Forces

$N_p := 2$ number of pipes

$\Sigma_x := R_{xp} \cdot N_p + R_{xpr} \cdot N_p = 532.534\ lbf$ — Sum of forces in the x-direction

$\Sigma_y := R_{yp} \cdot N_p + R_{ypr} \cdot N_p = \left(1.286 \cdot 10^3\right)\ lbf$ — Sum of forces in the y-direction

$R_f := \sqrt[2]{{\Sigma_x}^2 + {\Sigma_y}^2} = \left(1.392 \cdot 10^3\right)\ lbf$ — Resultant thrust force from velocity and pressure

Required Ballast

$W_p := 6.4\ lb$ — weight of pipe/ft table 5-8 ADS design handbook

$W_w := \gamma_w \cdot A_{pipe} \cdot 1\ ft = 110.27\ lb$ — weight of water per ft of pipe

$H_c := 2.5\ ft$ $Width_c := 3\ ft$ $L_c := 3\ ft$ — Dimensions of equivalent bulk bag

$\gamma_{soil} := 115\ pcf$ — unit weight of soil

$W_c := H_c \cdot L_c \cdot Width_c \cdot \gamma_{soil} = \left(2.588 \cdot 10^3\right)\ lbf$ — weight of bulk bag

$\delta_{bag} := 38\ deg$ — interface friction angle between bag and ground

$FS := 1.2$ — Required factor of safety against sliding

$W_{breq} := \dfrac{R_f \cdot FS}{\tan\left(\delta_{bag}\right)} = \left(2.137 \cdot 10^3\right)\ lbf$ — Required bag weight to resist sliding

$N_{bags} := \dfrac{\left(W_{breq}\right)}{W_c} = 0.826$ — Number of Bags to Resist Sliding

Soil Resistance and thrust Block (assumed):

$\gamma_{con} := 155\ pcf$ — Assumed unit weight concrete

$Ko := 1 - \sin\left(30\ deg\right) = 0.5$ — Assumed passive earth pressure coefficient of soil

$H_c := 2\ ft \qquad Width_c := 2\ ft \quad L_c := 3\ ft$

Dimensions of equivalent concrete block

$W_c := H_c \cdot L_c \cdot Width_c \cdot \gamma_{con} = \left(1.86 \cdot 10^3\right)\ lbf$

weight of concrete block

$$F_{soil} := Ko \cdot \left(\left(D_{cover} + \frac{OD}{2} \right) \cdot \gamma_{soil} \right) \cdot OD \cdot 1\ ft = 623.715\ lbf$$

available soil force across pipe to resist thrust

$W_{creq} := R_f \cdot FS = \left(1.67 \cdot 10^3\right)\ lbf$

Required force to resist thrust

$$P_{creq} := \frac{W_{creq}}{OD} = 910.851\ \frac{lbf}{ft}$$

Required pressure across the pipe to resist thrust

Fsoil < Wcreq so thrust block needed

$A_{conc} := 2\ ft \cdot 3\ ft = 6\ ft^2$

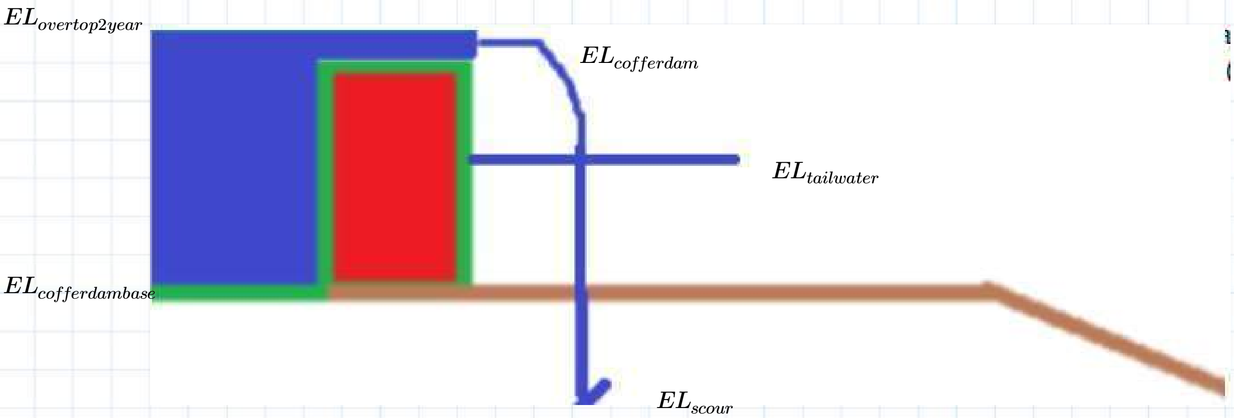
area of a concrete block 2x2x3

$$F_{block} := Ko \cdot \left(\left(D_{cover} + \frac{H_c}{2} \right) \cdot \gamma_{soil} \right) \cdot L_c\ ft = \left(1.035 \cdot 10^3\right)\ lbf$$

available soil force across 2x2x3 concrete block to resist thrust

Fblock > Wcreq so 1, 2x2x3 thrust block OK

Riprap Scour Calculations:



Parameters

$EL_{overtop2year} := 826.3\ ft$ — 2yr storm elevation for TOC of 825.0

$EL_{cofferdam} := 825.0\ ft$ — Top of cofferdam of 825.0

$EL_{cofferdambase} := 822.35\ ft$ — Bottom of cofferdam

$EL_{tailwater2year} := 824.0\ ft$ — Overtopping will occur at a slow rate; tailwater is anticipated to develop for the short term conditions

$Q_{2year} := 244.0\ \frac{ft^3}{s}$ — Based on Streamstats Report

Veronese 1973: determination of scour depth without riprap protection

2-year storm

$$z_s = K * h_d^{\,0.225} * q^{0.54}$$

$K := 1.32$ Empirical coefficient associated with Veronese 1973

$h_d := EL_{overtop2year} - EL_{tailwater2year} = 2.3\ ft$ difference in water elevations

$L := 70\ ft$ Length of embankment/ cofferdam subject to overtopping

$q := \dfrac{Q_{2year}}{L} = 3.486\ \dfrac{ft^2}{s}$ discharge per unit length of cofferdam

$h_d := \dfrac{h_d}{ft} = 2.3$

$q := \dfrac{q}{\left(\dfrac{ft^2}{s}\right)} = 3.486$ remove units for formula calculation

$Zs := K \cdot h_d^{\,.225} \cdot q^{.54} = 3.125$ formula solves for ft of scour

$Zs := Zs \cdot ft = 3.125\ ft$ Scour anticipated to reach base of cofferdam. The formulation does not include effects of scour protection

Schoklitsch

2-year

$$h_s = \frac{3.15}{D_n^{0.32}} H^{0.2} q^{0.57}$$

$\gamma_r := 150\ \dfrac{lb}{ft^3}$ Unit weight of riprap material

$V_r := \dfrac{350\ lb}{\gamma_r} = 2.333\ ft^3$ Volume of riprap material based on dumped riprap M2.02.2

$$R_r := \left(\frac{3}{4} \cdot \frac{V_r}{\pi}\right)^{\left(\frac{1}{3}\right)} = 0.823\ ft$$

Radius of riprap material

$$D_n := 2 \cdot R_r = 501.581\ mm$$

Assuming the D90 of the riprap material

$$H := EL_{overtop2year} - EL_{tailwater2year} = 2.3\ ft$$

Difference in water elevations

$$q := \frac{Q_{2year}}{L} = 3.486\ \frac{ft^3}{s \cdot ft}$$

Discharge per unit length of cofferdam

$$D_n := \frac{D_n}{mm} = 501.581$$

$$H := \frac{H}{ft} = 2.3$$

$$q := \frac{q}{\frac{ft^3}{s \cdot ft}} = 3.486$$

$$h_s := \frac{3.15}{D_n^{.32}} \cdot H^{.2} \cdot q^{.57} \cdot ft = 1.037\ ft$$

Scour depth below tailwater

$$EL_{tailwater2year} - h_s - EL_{cofferdambase} = 0.613\ ft$$

Scour is NOT anticipated should the D90 of bedding material be 501.6 mm. Single layer of riprap atop polyethylene sheeting will be sufficient.

Calculation Cover Sheet

Project #: 21136.00 **Calculation #:** 001
Project: Lock Pond Road Control of Water **Date:** 08/05/2021
Subject/Task: Discharge Rip Rap
Status: -
Revision Summary :

Revision #	Description	Date
1	Original Calculation	08/05/2021

Description: Determine the required geometry of a riprap for dissipating energy from the 18-inch diameter by-pass pipes.

References:

1. "Design Guide MD #6: Riprap Design Methods – A Collection of Design Examples and Related Information". Natural Resources Conservation Service, Maryland. January 2004.
2. Hwang, Ned and Houghtalen, Robert. "Fundamentals of Hydraulic Engineering Systems" 4th Edition. 1996.
3. HydroCAD results

Assumptions:

1. Intake inverts for pipes is at elevation 822.5
2. Discharge inverts for pipes is at elevation 821.5.
3. Length of the pipes is 170+/- feet.
4. Top of cofferdam elevation is 825 feet (allows head pressure build up)
5. From HydroCAD results analyzing the assumed pipe configuration maximum discharge flows are estimated to be 9.5 cfs from each pipes.
6. Assume no tailwater/free-discharge if upstream water is below 825.0 feet.
7. Riprap will be installed at the discharge to limit scour in the existing river bed.

Methodology:

Flow Calculations: Flow rate from the assumed conditions were determined from a HydroCAD analysis with the above stated assumptions. An overall discharge capacity from the pipes of 19 cfs was determined. This equates to 9.5 cfs from each pipe. Through an 18-inch diameter (22-inch OD) pipe this equates to a pipe discharge velocity of 5.4 ft/sec

♦
10 LINCOLN ROAD, SUITE 103 FOXBORO, MA 02035 8 BLACKSTONE VALLEY PLACE LINCOLN, RI 02865
T 508.543.1755 F 508.543.1881 T 401.334.4100 F 401.334.4108

Conclusions: Under elevated tailwater conditions a 10 foot long by 5.5 foot wide apron of 1-inch D_{50} material is needed. Under minimum tailwater conditions a 10-foot long by 11.5-foot wide apron of 4-inch D_{50} material is required.

Recommendations:

Recommendation is to install the required M2.02.2 dumped riprap as called for on the plans at the pipe discharges. Size of the proposed riprap is larger than the required stone to protect from scour so reducing the overall apron lengths/widths is acceptable as shown on Sheet 2.0 is acceptable at the pipe discharges.

If existing channel bedding meets these requirements additional riprap is not needed.

♦
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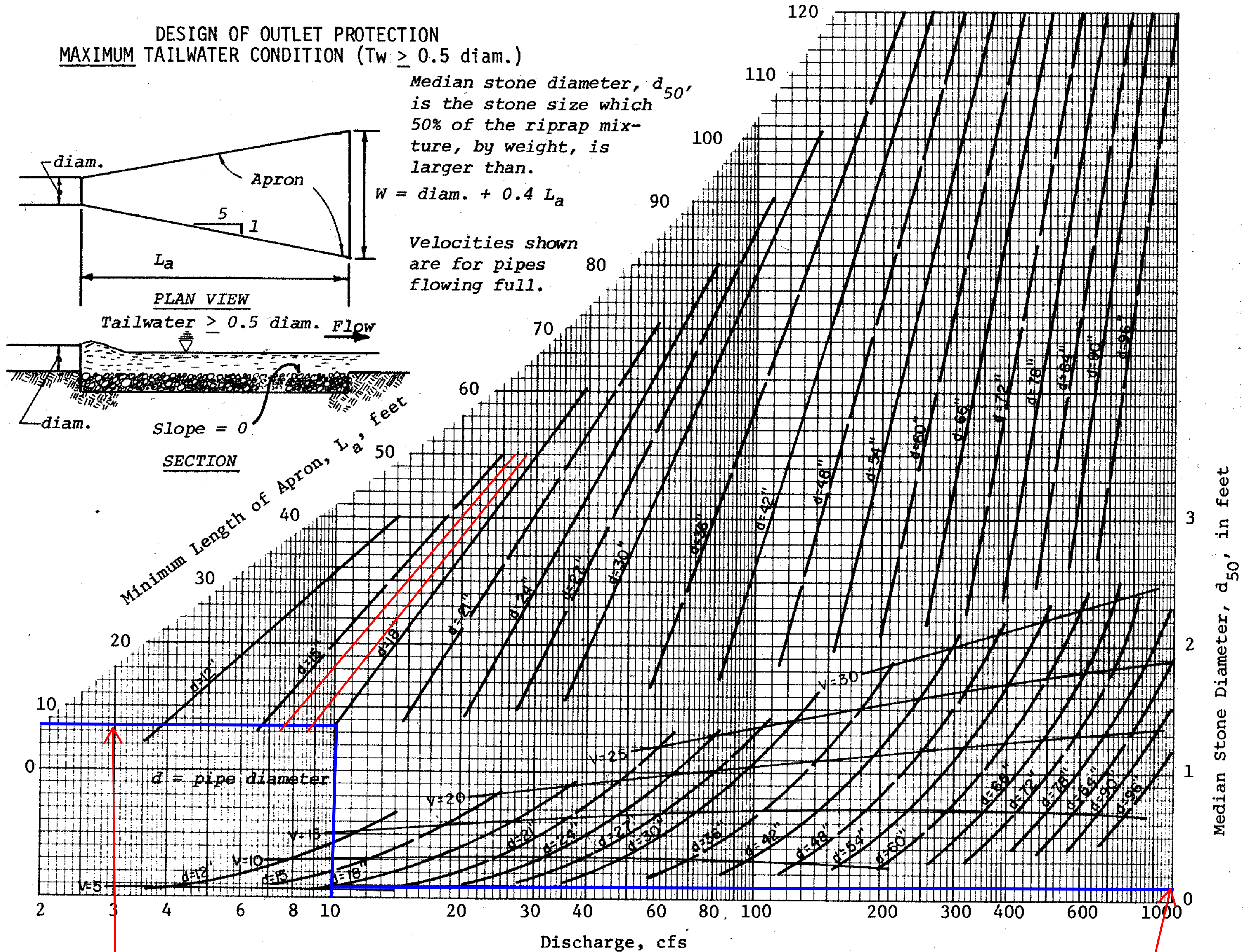
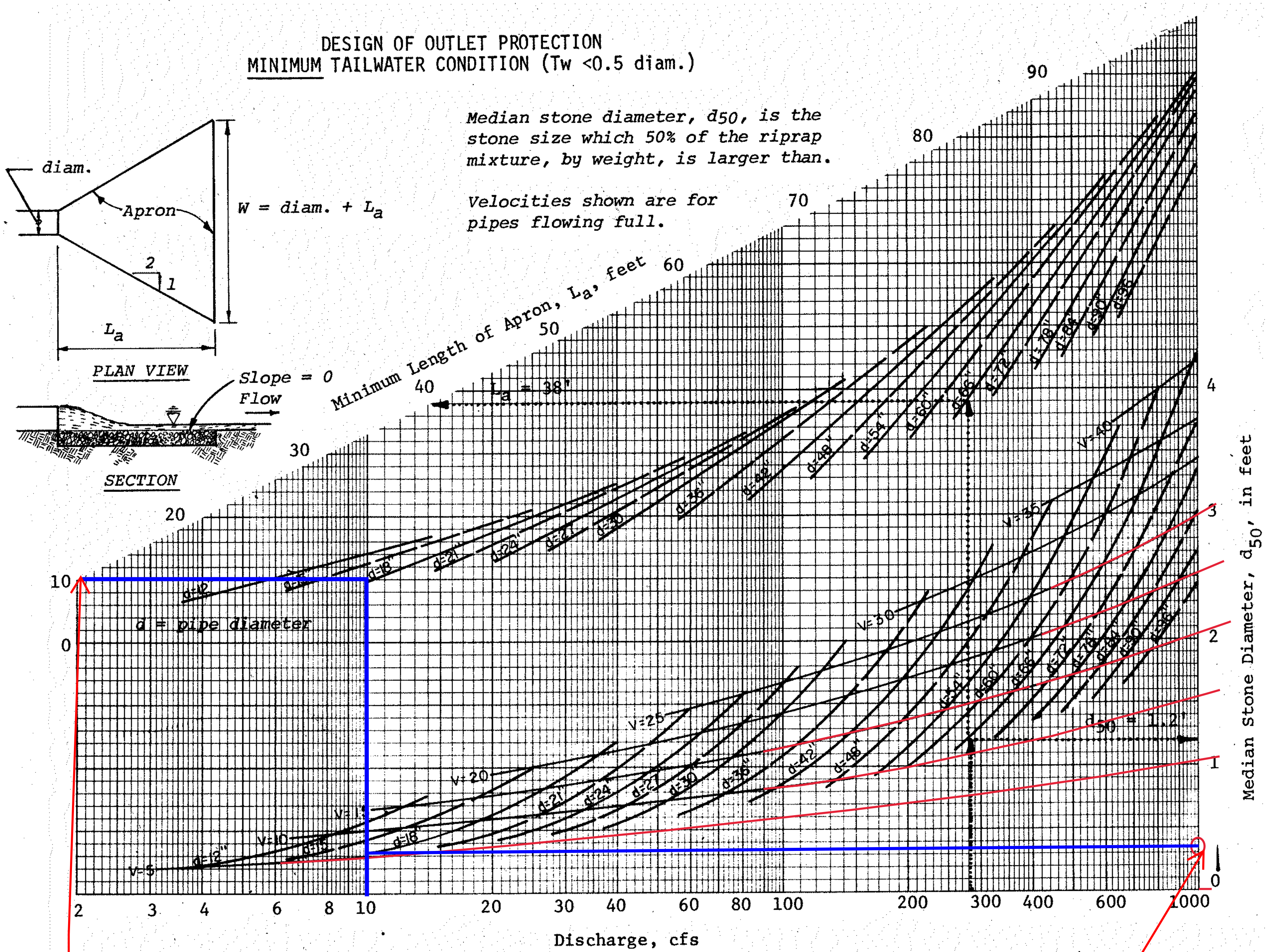


requires a 10 foot long x 5.5 foot wide apron.

d50 of 1-inches

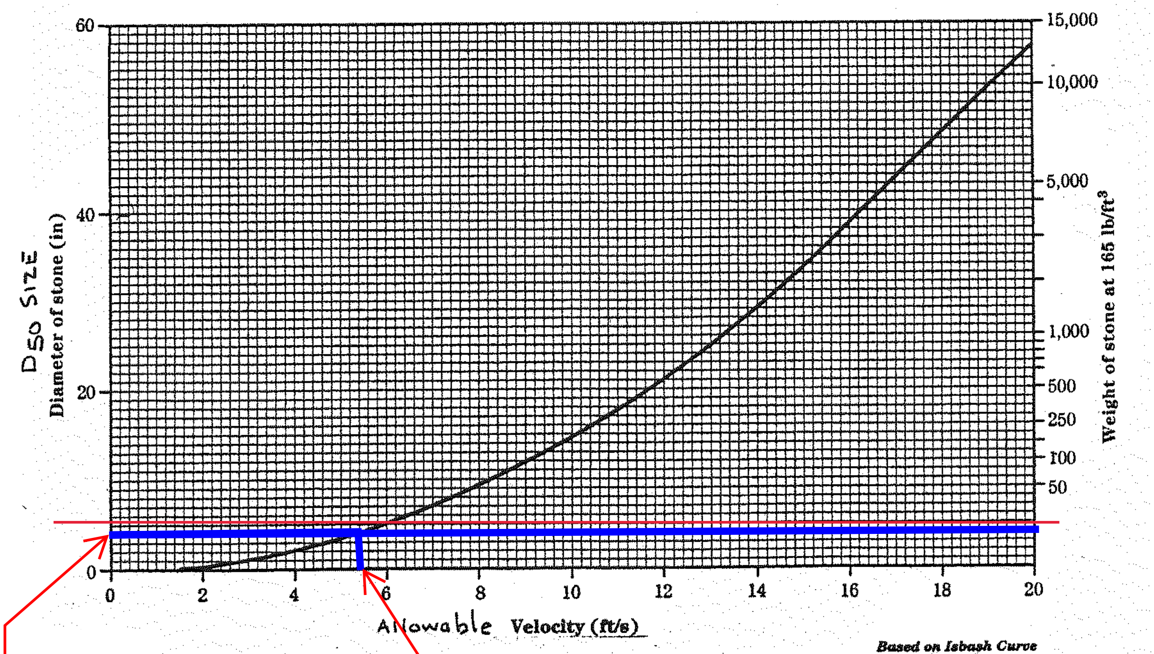
Sheet 3 of 3

DESIGN OF OUTLET PROTECTION
MINIMUM TAILWATER CONDITION (Tw <0.5 diam.)



requires a 10 foot long x 11.5 foot wide apron.

d50 of 3.5-inches



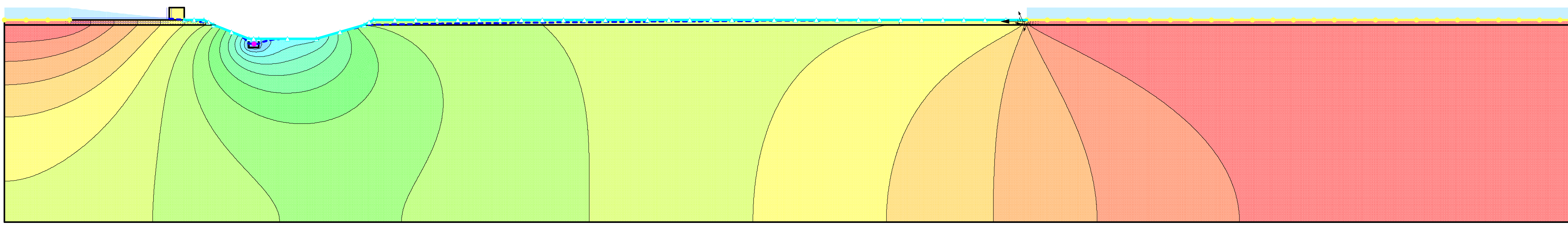
D50 of 4-inches therefore 10-inch minus stone acceptable.

Procedure
1. Determine the design velocity.
2. Use velocity and fig. 16A-1 (Isbash Curve) to determine basic rock size.
3. Basic rock size is the D_{50} size.

5.4fps (9.5 cfs from a 18-inch dia pipe)

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION
Top of Cofferdam = 825 feet
Upstream water = 825 feet
Downstream water = 822 feet
Excavation slopes = 2H:1V

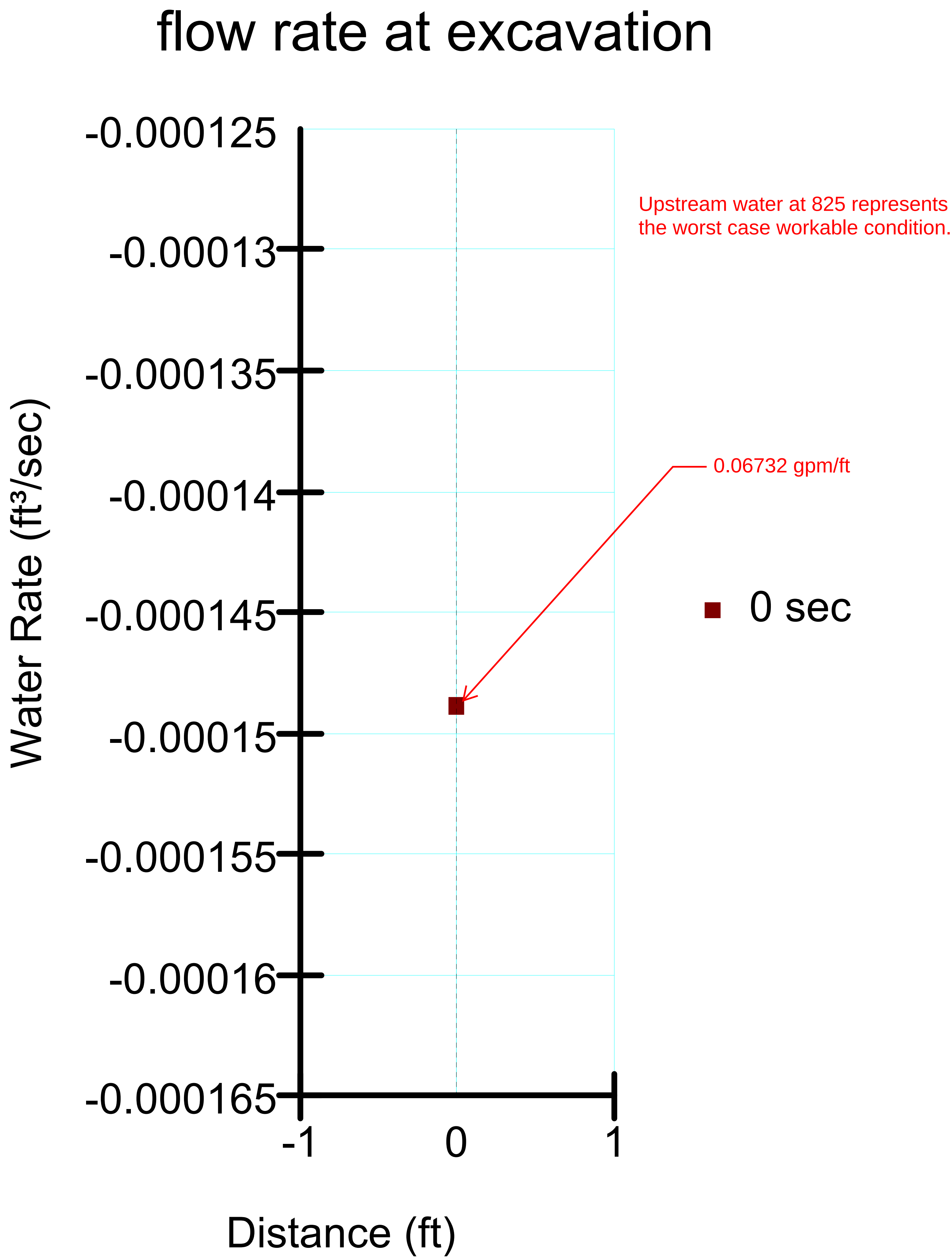
Upstream water at 825 represents the worst case workable condition.



Color	Name	Category	Kind	Parameters
(yellow)	825 top of cofferdam flow	Hydraulic	Water Total Head	825 ft
(cyan)	Drainage	Hydraulic	Water Rate	0 ft³/sec
(magenta)	SUMP	Hydraulic	Water Pressure Head	0 ft

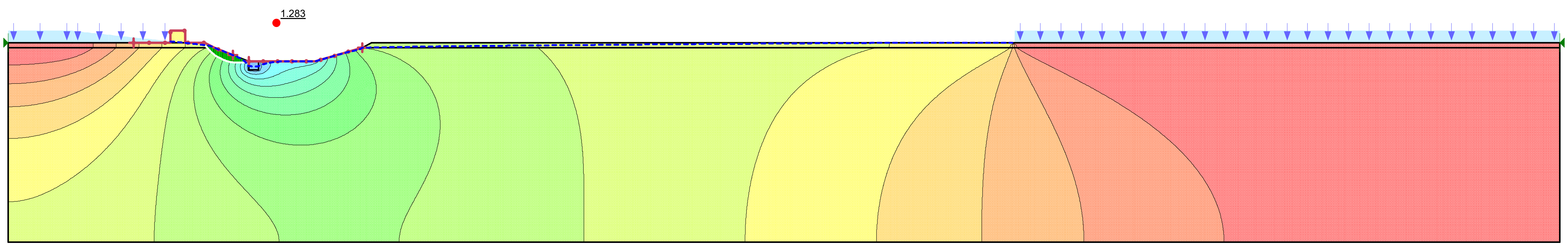
Color	Name	Material Model	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)
(light green)	M.dense Sand	Saturated / Unsaturated	M.Dense Sand	m.dense sand	0.5	0
(orange)	River Bed	Saturated / Unsaturated	River bed	River Bed	1	0
(olive)	sand bags	Saturated / Unsaturated	M.Dense Sand	m.dense sand	1	0

2:1 Bags - seep const flow	
Seep&SLope - 825&827.gsz	
08/05/2021	1:241


flow rate at excavation
-0.000125
-0.00013
-0.000135
-0.00014
-0.000145
-0.00015
-0.000155
-0.00016
-0.000165
Water Rate (ft³/sec)
-1
0
1
Distance (ft)
Upstream water at 825 represents
the worst case workable condition.
0.06732 gpm/ft
0 sec

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION
Top of Cofferdam = 825 feet
Upstream water = 825 feet
Downstream water = 822 feet
Excavation slopes = 2H:1V
Critical slope failure FS shown

Upstream water at 825 represents the worst case workable condition.



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Vol. WC. Function	Residual Water Content (% of Sat WC) (%)
	M.dense Sand	Mohr-Coulomb	115	0	37	M.Dense Sand	20
	River Bed	Mohr-Coulomb	125	0	36	River bed	10
	sand bags	High Strength	115				

Slope Stability const flow	
Seep&SLope - 825&827.gsz	
08/05/2021	1:241

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION

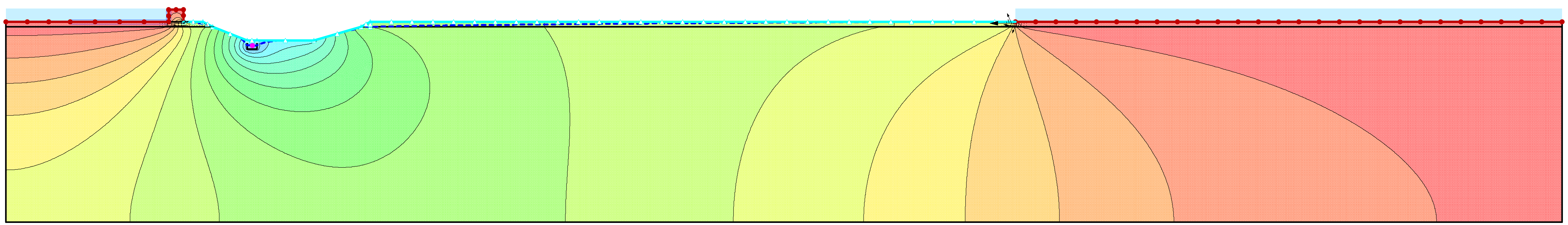
Top of Cofferdam = 825 feet

Upstream water = 825.3 feet

Downstream water = 822 feet

Excavation slopes = 2H:1V

Upstream water at 825.3 represents the worst case non-workable condition as cofferdam is overtopping and work area is flooding.



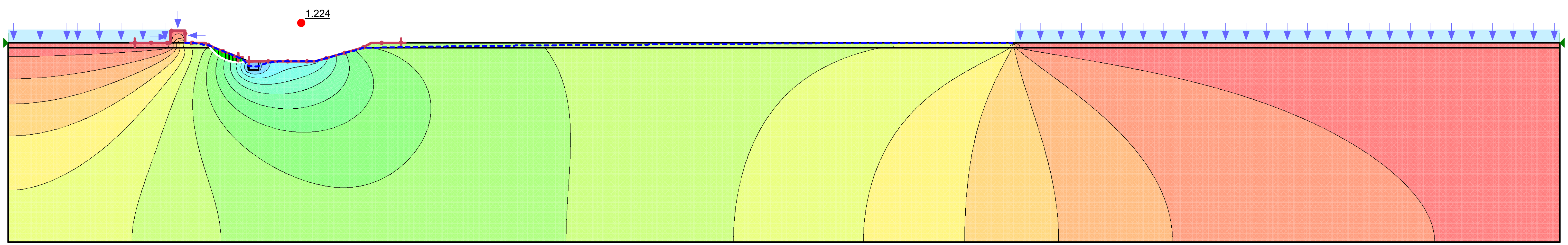
Color	Name	Material Model	Vol. WC. Function	K-Function	Ky'/Kx' Ratio	Rotation (°)
(light green)	M.dense Sand	Saturated / Unsaturated	M.Dense Sand	m.dense sand	0.5	0
(orange)	River Bed	Saturated / Unsaturated	River bed	River Bed	1	0
(olive)	sand bags	Saturated / Unsaturated	M.Dense Sand	m.dense sand	1	0

Color	Name	Category	Kind	Parameters
(red)	825 flood flow START	Hydraulic	Water Total Head	825.2 ft
(cyan)	Drainage	Hydraulic	Water Rate	0 ft³/sec
(magenta)	SUMP	Hydraulic	Water Pressure Head	0 ft

2:1 Bags - seep flood flow start	
Seep&SLope - 825&827.gsz	
08/05/2021	1:241

COFFERDAM SEEPAGE AND SLOPE STABILITY - HIGH FLOW CONDITION
Top of Cofferdam = 825 feet
Upstream water = 825.3 feet
Downstream water = 822 feet
Excavation slopes = 2H:1V

Upstream water at 825.3 represents the worst case non-workable condition as cofferdam is overtopping, cofferdam has lost its seal, and work area is flooding.



Color	Name	Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Vol. WC. Function	Residual Water Content (% of Sat WC) (%)
	M.dense Sand	Mohr-Coulomb	115	0	37	M.Dense Sand	20
	River Bed	Mohr-Coulomb	125	0	36	River bed	10
	sand bags	High Strength	115				

Slope Stability flood flow start	
Seep&SLope - 825&827.gsz	
08/05/2021	1:241

N-12® ST IB PIPE (PER ASTM F2648)

N-12 corrugated dual-wall pipe was introduced in 1987. Today's N-12 ST IB pipe (per ASTM F2648) is an engineered compound of virgin and recycled high density polyethylene resins to provide impressive material properties. The performance you've come to expect from N-12, with the added benefit of helping to promote responsible use of resources. Available in diameters from 4" to 60" (100 to 1500 mm), N-12 pipe is replacing reinforced concrete pipe as a preferred product for storm water applications.

ADS N-12 ST IB pipe (per ASTM F2648) contains a superior built-in bell-and-spigot joint. The joints are sealed by high-quality, factory-installed rubber gaskets that meet all the requirements of ASTM F477. A polyethylene bell minimizes joint distortion. The chipping and cracking that is common to concrete bells, is eliminated.

APPLICATIONS:

Storm Drains
Retention/Detention
Golf, Turf & Recreation
Culverts/Cross Drains
Grain Aeration
Waterways
Ditch Enclosures
Slope/Edge Drains
Mining/Forestry/Industrial
Foundation Drains
Downspouts/Roof Drainage
Land Reclamation
Terracing

FEATURES:

- 4" – 60" (100 to 1500 mm) diameters available
- Nominal 20 ft (6m) and 13 ft (4m) lengths available
- Bell and spigot joint design
- In-line bell design
- Exceptional joint strength
- Excellent abrasion and corrosion resistance
- Light weight
- Fast installation times
- Structural strength will support H-25 live loads with 12" (300mm) minimum cover; 60" (1500mm) pipe requires 2' (0.6mm) cover for H-25 loads

BENEFITS:

- Variety of diameters and lengths that will fit in any project
- Joint only requires lube for fitting – ends are pushed together for easy field installation
- Unlike pipe from other manufacturers, there are no additional gasket materials, grout or sealing bands to transport and apply
- Installation cost savings from lower shipping costs, fewer people, and less heavy equipment required
- Hydraulic efficiency from smooth interior
- Long-term durability of HDPE

ADS Service: ADS representatives are committed to providing you with the answers to all your questions, including specifications, and installation and more.

ADS N-12® ST IB PIPE (PER ASTM F2648) SPECIFICATION

SCOPE

This specification describes 4- through 60-inch (100 to 1500 mm) ADS N-12 ST IB pipe (per ASTM F2648) for use in gravity-flow land drainage applications.

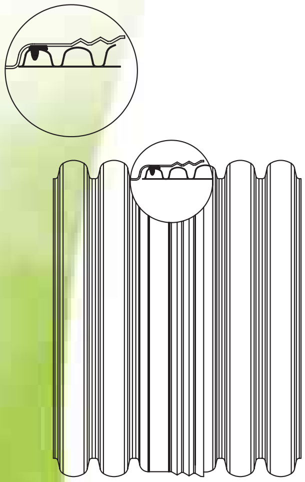
PIPE REQUIREMENTS

ADS N-12 ST IB pipe (per ASTM F2648) shall have a smooth interior and annular exterior corrugations.

- 4- through 60-inch (100 to 1500 mm) shall meet ASTM F2648.
- Manning's "n" value for use in design shall be 0.012.

JOINT PERFORMANCE

Pipe shall be joined using a bell & spigot joint meeting ASTM F2648. The joint shall be soil-tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.



FITTINGS

Fittings shall conform to ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of ASTM F2306.

MATERIAL PROPERTIES

Material for pipe production shall be an engineered compound of virgin and recycled high density polyethylene conforming with the minimum requirements of cell classification 424420C, (ESCR Test Condition B) for 4- through 10-inch (100 to 250 mm) diameters, and 435420C, (ESCR Test Condition B) for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The design engineer shall verify compatibility with overall system including structural, hydraulic, material and installation requirements for a given application.

INSTALLATION

Installation shall be in accordance with ASTM D2321 and ADS's published installation guidelines, with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot (0.3 m), and for 60-inch (1500 mm) diameters, the minimum cover shall be 2 ft (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1 (compacted), or Class 2 (minimum 90% SPD) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.02. Contact your local ADS representative or visit our website at www.ads-pipe.com for a copy of the latest installation guidelines.

PIPE DIMENSIONS

	Nominal Diameter, in (mm)												
Pipe I.D., in. (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	60 (1500)
Pipe O.D.**, in. (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	67 (1702)
Perforations	All diameters available with or without perforations.												

* Check with sales representative for availabiltiy by region.
**Pipe O.D. values are provided for reference purposes only, values stated for 12- through 60-inch are ± 1 inch. Contact a sales representative for exact values.

For more information on ADS N-12 ST IB pipe (per ASTM F2648) and other ADS products, please contact our Customer Service Representatives at 1-800-821-6710.

BRO 10628 01/10 (08334)

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CUSTOMER SERVICE LINE

#14981-0-3 BULK BAG

SPEC#	**6B48SX**
Unfilled Dimension:	**43"x 39"x 38"**
Cubic Capacity:	**27 Cubic Feet**
Fill Spout:	**3oz./sq.yd. Coated UV Treated Woven Polypropylene** **14" diameter x 18" with ½" web tie**
Top Panel:	**3oz./sq.yd. Coated UV Treated Woven Polypropylene**
Body Fabric:	**6oz./sq.yd. Uncoated UV Treated Woven Polypropylene**
Bottom:	**Solid**
Lifting Loops:	**(4) 10" Long 5000lb strength lifting loops**
Liner:	**None**
Safe Work Load:	**3000 lbs at 5:1 safety factor**

Sewage and Trash Pump DV200cSA

Overview:

The 12" suction x 8" discharge self-priming centrifugal DV200cSA trash pump provides up to a maximum of 4,600 gallons per minute pumping and up to 260 feet of head. This trailer mounted pump is equipped with a sound attenuated enclosure package. The standard Clean Prime priming system allows continuous operation without pumping liquid carryover to contaminate the outside environment. The pump is also equipped with a Run-Dry feature, which provides the mechanical seal faces with continuous lubrication, even when there is no liquid in the pump casing.

Features:

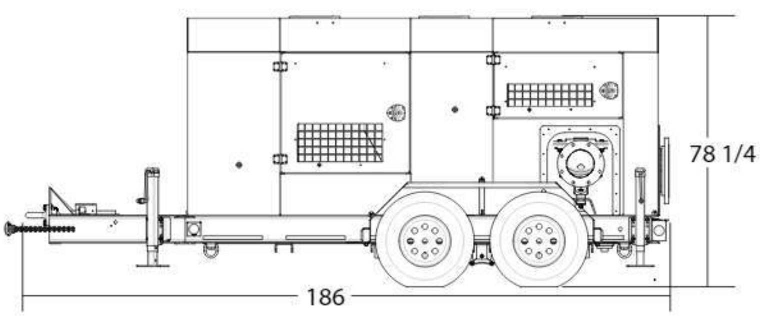
- Continuous self-priming
- Runs dry unattended
- 12 volt, electric start with auto-start capable control panel
- Flex coupled to diesel engine
- 24-hour minimum capacity fuel tank
- Air-Ejector (Venturi) priming system
- Cast iron wet end with closed impellers
- Replaceable wear plates
- SAE Mounted
- Suction lift up to 28ft.
- Sound Attenuation: 70dB(A) @ 30'

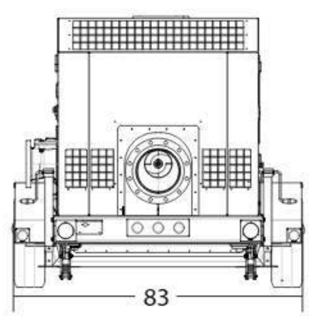
Specs:

Maximum Flow	4,600 GPM
Maximum Head	260 feet
Pump Size	12" x 8"
Maximum Solids Handling	3.375 inches
Dry weight	8,430 lbs.
Footprint: Trailer mounted model	186" x 83"
Fuel Capacity (usable)	180 gallon
Fuel consumption	7 gph @ 1,800 RPM

Accessories:

- Spillguard
- Suction and Discharge Hoses
- Fuel Nurse Tank





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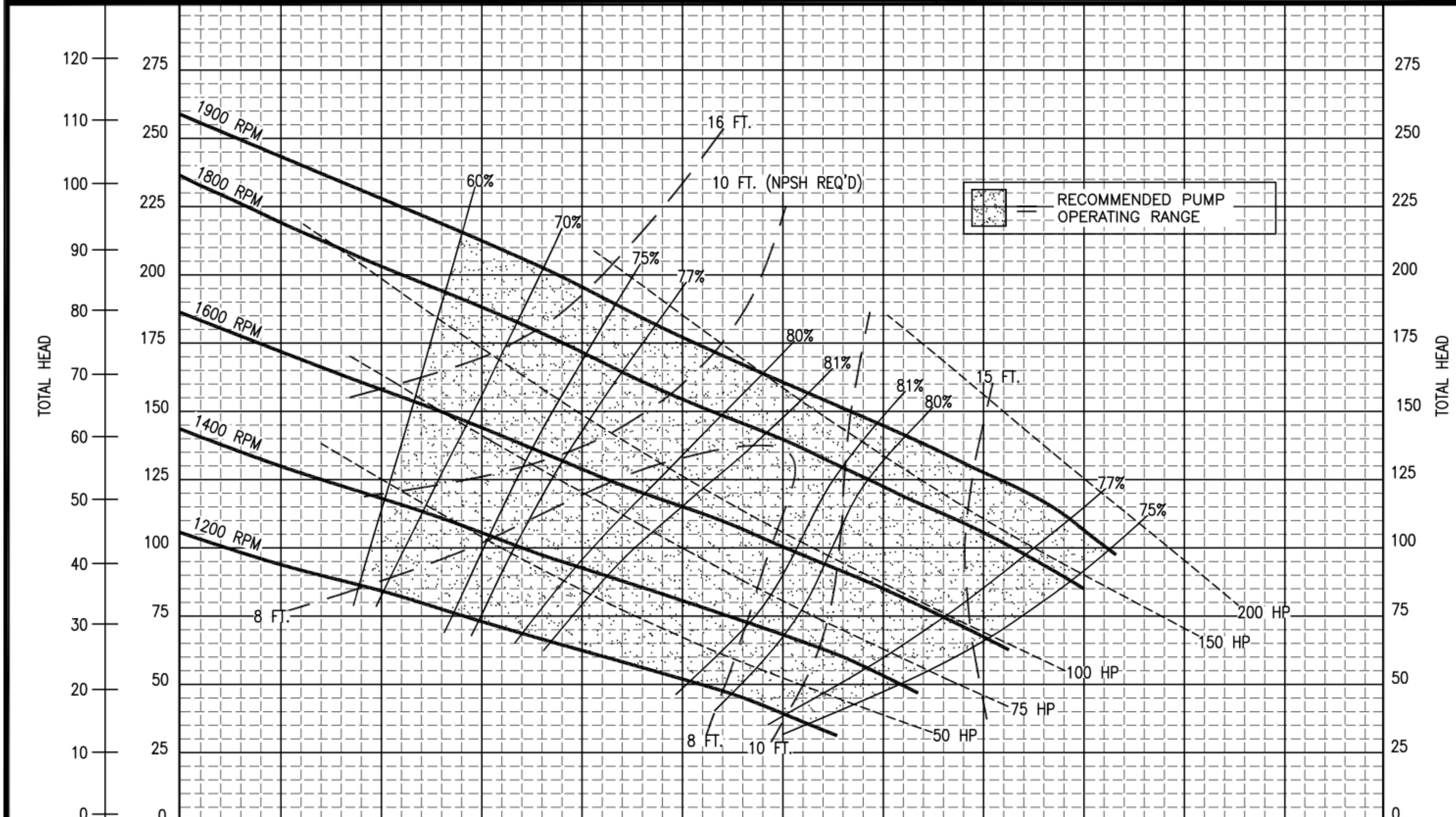
CURVE: 01-0133-02-16

PUMP : **DV-200c**

SUCTION	DISCHARGE	MAX. SPHERE	IMPELLER	IMPELLER	IMPELLER & WEAR RINGS
12"	8"	3.375"	2 VANE	14.00"	CAST IRON



FLOW – CLEAR WATER PERFORMANCE (US GPM)

–PUMP PERFORMANCE CURVES DO NOT INCLUDE CHECK VALVE LOSSES

–POWER CURVES DO NOT INCLUDE PRIMING SYSTEM POWER CONSUMPTION

CONFIDENTIAL

DIRTBAG®
DEWATERING BAG

SEDIMENT AND PERIMETER CONTROL

FILTERS SILT, SAND, AND FINES OUT OF PUMPED WATER

Dirtbag dewatering bags remove silt, sand, and other debris from pumped water on construction sites, ponds, dredging locations and more.

The bag easily connects to a pump discharge hose using the 4” neck and sewn in attachment straps. To increase the effectiveness of Dirtbag’s filtration system, ACF Environmental recommends placing the product on a bed of hay bales or aggregate to maximize water flow through the surface area of the bag. Doing so also helps protect the surrounding area from erosion, sediment displacement and the pollution of receiving waters. Under most circumstances, a 15x15 Dirtbag can pass up to 500 gallons of water per minute.

USE GUIDELINES:

- **Dirtbag must be monitored at all times during use (over-filling may cause rupture)**
- Flow and removal rates vary based on particle size/ sediment composition
- To increase flow rate place Dirtbag on aggregate, straw bales, or other porous surfaces
- Dirtbag is full when it can no longer efficiently pass water at a reasonable rate

ADVANTAGES:

- High flow rate
- 15’ x 15’ Dirtbag is rated up to 500 GPM pump
- Built-in neck receives up to 4” discharge hose
- Removes sediment, trash, and debris
- Economical alternative to other methods
- Custom sizes available upon request

9.19

Full product specifications are available on the Dirtbag product page at www.acfenvironmental.com

SPECIFICATIONS

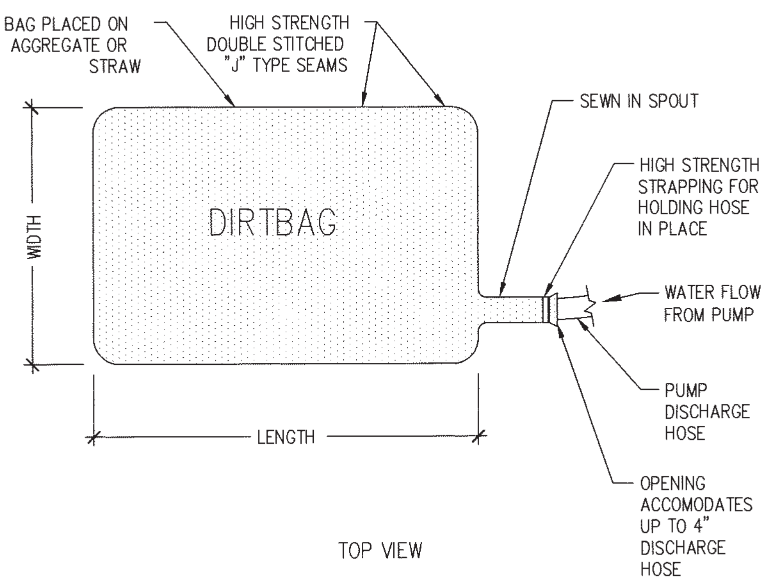
Dirtbag sizes include: 4′ x 6′ | 5′ x 5′ | 8′ x 10′ | 10′ x 10′ | 15′ x 15′ | and custom sizes on request

PROPERTY	TEST METHOD	MARV
Weight	ASTM D3776	8 oz/yd
Grab Strength (Tensile)	ASTM D4632	205 lbs
CBR Puncture	ASTM D6241	525 lbs
UV Resistance	ASTM D4355	70%
Apparent Opening Size (AOS)	ASTM D4751	80 US std. sieve
Flow Rate	ASTM D4491	90 gal/min/ft^2
Permittivity	ASTM D4491	1.4 sec^{-1}

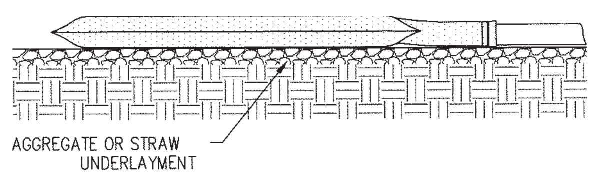
Dirtbag® seam test results (ASTM D4884)

NONWOVEN DIRTBAG	WOVEN DIRTBAG
Maximum load 786 lbs	Maximum load 934 lbs
Maximum strength 1178 lb/ft	Maximum strength 1402 lb/ft

NOTE: Each test result was derived from a material failure rather than a stitch failure.



TOP VIEW



SIDE VIEW

Testing Details:

Dirtbag has been tested under ASTM D-7880 and ASTM-7701. These are standard test methods for determining flow rate of water and suspended solids retention from a closed geosynthetic bag. Testing summary available upon request.

ACF ENVIRONMENTAL
LET'S GET IT DONE
800.448.3636
acfenvironmental.com

DISCLAIMER: Use of dewatering bags is a standard construction method throughout the U.S. ACF Environmental in not liable for any damage caused by rupture or over-filling of Dirtbag. If Dirtbag fails to fully pass pumped water, turn off pump and contact ACF Environmental at 800-448-3636.